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PROCEEDINGS

OF THE

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

VOL. XLV—No. 6

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

August, 1919

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OF THE

AMERICAN SOCIETY

OF

CIVIL ENGINEERS

(INSTITUTED 1852)

VOL. XLV—No. 6

AUGUST, 1919

Edited by the Secretary, under the direction of the Committee on Publications.

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CONTENTS

Society Affairs.....Pages 535 to 794.
Papers and Discussions.....Pages 397 to 610.

NEW YORK 1919

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ON THE REGULATION OF WATER RIGHTS: F. H. Newell, W. C. Hoad, John H. Lewis.

TO REPORT ON STRESSES IN RAILROAD TRACK: A. N. Talbot, A. S. Baldwin, G. H. Bremner, John Brunner, W. J. Burton, Charles S. Churchill, W. C. Cushing, Robert W. Hunt, George W. Kittredge, Paul M. LaBach, C. G. E. Larsson, G. J. Ray, Albert F. Reichmann, H. R. Safford, F. E. Turneaure, J. E. Willoughby.

The Reading Room of the Society is open from 9 A. M. to 10 P. M. every day, except Sundays, New Year's Day, Fourth of July, Labor Day, Thanksgiving Day, and Christmas Day; during July and August, it is closed at 6 P. M.

HEADQUARTERS OF THE SOCIETY—33 WEST THIRTY-NINTH STREET, NEW YORK.

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AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852.

PROCEEDINGS

This Society is not responsible for any statement made or opinion expressed in its publications.

SOCIETY AFFAIRS

CONTENTS

Minutes of Meetings:	PAGE
Of the Society, May 21st and June 4th, 1919	535
Of the Forty-ninth Annual Convention, June 17th-20th, 1919	540
Elections and Transfers by the Board of Direction, June 16th, 1919	541
Of the Board of Direction, June 16th, 1919	544
Report in Full of the Business Meeting, June 17th, 1919, at the Forty-ninth Annual Convention	548
Excursions and Entertainments during the Forty-ninth Annual Convention	575
Attendance at the Forty-ninth Annual Convention	577
Address by F. C. Shenehon, M. Am. Soc. C. E.	580
Report of the Committee on Development	589
Report of the Delegation of American Engineers to France	604
Items of Interest	681
Announcements:	
Hours during which the Reading Room is open	707
Future Meetings	707
How to Make Remittances to the Society	707
Roll of Honor	707
Engineering Societies Employment Bureau	707
Searches in the Library	708
Papers and Discussions	708
Local Associations of Members of the American Society of Civil Engineers	709
Privileges of Engineering Societies Extended to Members	728
New Books	729
Membership (Additions, Reinstatements, Resignations, Deaths)	738
Recent Engineering Articles of Interest	752

MINUTES OF MEETINGS OF THE SOCIETY

May 21st, 1919.—The meeting was called to order at 8.30 P. M.; D. Bontecou, M. Am. Soc. C. E., in the chair; Chas. Warren Hunt, Secretary; and present, also, 130 members and guests.

Joseph Dean Evans, M. Am. Soc. C. E., Vice-President of the Atlantic Loading Company, addressed the meeting on "Fixed Ammunition Loading, Inspecting, and Firing," illustrating his remarks with official moving pictures prepared by the United States Government. The details of the subject were explained further by Lt.-Col. H. C.

Davis, Jr., of the Explosives, Chemical, and Loading Division of the War Department, and Lt.-Col. Arthur Adams, M. Am. Soc. C. E., of the Ordnance Department, also spoke.

The Secretary presented an invitation from Mr. Walter R. Harper, Resident Representative of the U. S. Shipping Board, to members of the Society to attend the launching of the 3 500-ton concrete ship *Polias,* at North Beach, Long Island, on May 22d, 1919, at 4.30 P. M.

The Secretary announced the election of the following candidates on May 12th, 1919:

As Members

Frank Seymour Baillie, Portland, Ore.
Pierre Charton, St. Nazaire, France
Josiah Huntington Fitch, New York City
Frank McClellan Gunby, Washington, D. C.
George Trowbridge Hand, South Orange, N. J.
Winters Haydock, Washington, D. C.
Jules Joseph Hennebique, New York City
Edward Albert Kemmler, Akron, Ohio
Max Werner King, Buffalo, N. Y.
Richard Coke Marshall, Jr., Washington, D. C.
Warren Rabun Neel, Atlanta, Ga.
John Burchfield Neely, Kansas City, Mo.
Bunkichi Okazaki, Tokyo, Japan
Charles Edward Paul, Chicago, Ill.
Frank Edson Perkins, Brunswick, Ga.
Warren Russell Roberts, Chicago, Ill.
Paul Sterling, West Haven, Conn.
Joseph Boyer Townsend, Houston, Tex.
Clark Chittenden Wright, Washington, D. C.
George Stevenson Yates, London, England

As Associate Members

Arthur Rich Alling, McGehee, Ark.
Edwin Percival Arneson, Washington, D. C.
Roy Arin Badt, San Francisco, Cal.
Charles Nicholas Bley, Berkeley, Cal.
James Singleton Clay, Washington, D. C.
John Hamilton Cosby, Cambridge, Md.
James Edward Cuff, Edgewood, Md.
Paul Ashmore Daniells, Greenville, Pa.
Raymond Earl Davis, San Francisco, Cal.
Charles John Emerson, Groveland, Cal.
Abraham Epstein, Chicago, Ill.

Arthur Lee Ferver, East San Pedro, Cal.
Philip Bracken Fleming, Camp A. A. Humphreys, Va.
Frederick Glaeser, Trenton, N. J.
Lester Carlisle Gustin, Cambridge, Mass.
Fred Ernest Hanson, West Haven, Conn.
Frank William Harris, Renton, Wash.
Randolph Harrison, Lake Charles, La.
Henry Harvie, Toronto, Ont., Canada
Richard Lankaster Hearn, Toronto, Ont., Canada
Solomon Cady Hollister, Philadelphia, Pa.
Charles Warren Hughes, Port Arthur, Tex.
Lee Harvey Huntley, Tapoco, N. C.
Harold Sucese Johnson, Chicago, Ill.
Prescott Vail Kelly, Pittsburgh, Pa.
Harold Julius Levine, New York City
Solon Baron Mandell, New York City
Leslie Stancliffe Marshall, West Collingswood, N. J.
Joe Burrow Mullins, Nashville, Tenn.
Patrick Henry Myers, Cuyamel, Honduras
Harrison Worth Nighswonger, Camp Funston, Kans.
Bethuel Sutherland Oakes, Wilmington, N. C.
Clarence Eugene Ridley, Port Arthur, Tex.
James Tillman Ryan, San Francisco, Cal.
George Henry Sargent, La Grange, Ga.
Thorndike Saville, Hampton, Va.
William James Shea, Hudson, N. Y.
Carlos Tejada Sorzano, La Paz, Bolivia
Lyman Robert Talbot, Muscle Shoals, Ala.
Marcus Prevost Taylor, Washington Barracks, D. C.
Samuel Houston Ware, Honolulu, Hawaii
Kinzie La Mar Weimer, Camp Hancock, Ga.
Rudolph Sigmund Weiner, El Paso, Tex.
Frank Hubble West, Hilo, Hawaii
Herman Calvert Witte, Philadelphia, Pa.
William Sidney Wolfe, North Glenside, Pa.

As Juniors

William John Camlin, Green Bay, Wis.
James Apker Foster, Jr., Yellow Creek, N. C.
James Rinaldo Griffith, New York City
John Edwin Harn, Baltimore, Md.
Wallace Byrne Kane, Joplin, Mo.
Albert Weigand Luhrs, Jersey City, N. J.
Thomas Francis McSweeney, Philadelphia, Pa.

En-Chao Miao, Lee Hall, Va.
Louis Wellington Robertson, El Paso, Tex.
Clifton Kennady Wells, Jr., Baltimore, Md.

The Secretary announced the transfer of the following candidates on May 12th, 1919:

From Associate Member to Member

Fred Edward Caldwell, East Orange, N. J.
John Farris, Pittsburgh, Pa.
Frank Demetrius Hayden, Seattle, Wash.
John Gibson Hendrie, Fort Worth, Tex.
Frederick William Kassebaum, Jr., Baltimore, Md.
Luther Hammond Lewis, New York City
Albert Roy Olds, Havana, Cuba
George Sykes, Bayside, N. Y.
Byron Ellsworth White, Utica, N. Y.

From Junior to Associate Member

Clifford Aull Betts, Chattanooga, Tenn.
Harold Crusius Bird, Chester, Pa.
Edward Withers Bowen, Cleveland, Ohio
Janik Kevork Dirats, Bordeaux, France.
James Wightman Follin, Washington, D. C.
Edmond Anthony Fretz, Houston, Tex.
John James Gault, Chicago, Ill.
Lewis Adams Holborn, Am. Exp. Forces, France.
Harry Lichtenstein, Tullytown, Pa.
John Stalker Longwell, Denver, Colo.
Adolph Joseph Post, Camp Devens, Mass.
Leonard Hanscome Sinclair, Washington, D. C.
Isaac Yost Stauffer, Batavia, Java
Fred LeRoy Stearns, Norwich, Conn.
Joseph Joslin Strachan, Boston, Mass.
William Edward Whalen, Toledo, Ohio
Emmet Cheatham Wilson, Birmingham, Ala.

The Secretary announced the following deaths:

Hermon Charles Allen, of Boise, Idaho, elected Member, May 2d, 1911; died May 4th, 1919.

Adna Dobson, of Lincoln, Nebr., elected Member, May 6th, 1908; died May 4th, 1919.

Homer Peter Ritter, of Boston, Mass., elected Member, November 3d, 1915; died April 21st, 1919.

Hermann Frederick August Schussler, of San Francisco, Cal., elected Member, February 4th, 1914; died April 27th, 1919.

Carl Uhlig, of San Francisco, Cal., elected Member, October 7th, 1903; died May 5th, 1919.

Rafael Joaquin Torralbas, of Santa Lucia, Oriente, Cuba, elected Junior, November 1st, 1910; Associate Member, June 24th, 1914; died September, 1918.

Adjourned.

June 4th, 1919.—The meeting was called to order at 8.30 p. m.; Vice-President Nelson P. Lewis in the chair; Chas. Warren Hunt, Secretary; and present, also, about 75 members and guests.

The minutes of the meetings of April 16th and May 7th, 1919, were approved as printed in *Proceedings* for May, 1919.

The meeting was devoted to an informal discussion on the organization of a Local Association of Members of the Society in the New York City District. The discussion was opened by D. L. Turner, M. Am. Soc. C. E., who was followed by Messrs. E. J. Mehren, Chas. Warren Hunt, S. N. Castle, T. Kennard Thomson, W. E. Belknap, E. T. Thurston, George H. Pegram, and T. Hugh Boorman.

The Secretary announced the following deaths:

Henry Burger Sauerman, of Chicago, Ill., elected Associate Member, May 1st, 1907; Member, May 31st, 1916; died May 20th, 1919.

Naoji Shiraishi, of Tokyo, Japan, elected Member, October 4th, 1899; died February 17th, 1919.

Emil Swensson, of Pittsburgh, Pa., elected Member, June 7th, 1893; died May 13th, 1919.

Allen Eugene Nichols, of Chicago, Ill., elected Associate Member, October 10th, 1916; died May 8th, 1919.

Burt Stimson, of Chicago, Ill., elected Associate Member, September 12th, 1916; died May 26th, 1919.

Adjourned.

FORTY-NINTH ANNUAL CONVENTION HELD IN ST. PAUL AND MINNEAPOLIS, MINN., JUNE 17th-20th, 1919.

FIRST SESSION.*

Tuesday, June 17th, 1919.—The meeting was called to order at the Radisson Hotel, Minneapolis, Minn., at 10 A. M.; R. D. Thomas, M. Am. Soc. C. E., President of the Northwestern Association of Members of the American Society of Civil Engineers, and Chairman of the Local Committee of Arrangements, presiding; Chas. Warren Hunt, Secretary; and present, also, about 200 members and guests.

Mr. Thomas introduced the Hon. J. A. A. Burnquist, Governor of Minnesota, who addressed the meeting and welcomed the members to the "Twin Cities."

President F. S. Curtis delivered the Annual Address.†

The Secretary presented a telegram‡ from Horace V. Winchell, President of the American Institute of Mining and Metallurgical Engineers, who had been invited to address the meeting on the "Mines of Minnesota", expressing regret at being unable to be present.

F. C. Shenehon, M. Am. Soc. C. E., addressed the meeting on "Engineering Activities of the Twin Cities."§

Adjourned.

SECOND SESSION—BUSINESS MEETING.‖

Tuesday, June 17th, 1919.—The meeting was called to order at 2 P. M.; President F. S. Curtis in the chair; Chas. Warren Hunt, Secretary; and present, also, about 220 members and guests.

The Secretary reported the result of the ballot on the proposed changes in the "Year Book" and the omission of "Changes of Address" in *Proceedings*.¶

The Secretary announced the election and transfer of candidates for membership by the Board of Direction on June 16th, 1919.**

On motion, duly seconded, the reading of the names of the candidates was omitted.

The Secretary presented the report of the Committee on Development,†† and stated that the report had been presented to the Board of

* For the Report in full of this meeting, see page 548.
† Printed on pages 437 to 442 of Papers and Discussions.
‡ See page 550.
§ See page 580.
‖ For the Report in full of the Business Meeting, see page 550.
¶ See page 550.
** See page 541.
†† See page 589.

Direction which had ordered printed copies to be sent to the membership of the Society and to the Local Associations, with the request that the benefit of individual or collective opinion on all fundamental points be communicated to the Chairman or Secretary of the Committee, in order that a further report might be prepared for presentation and discussion at the next Annual Meeting.

President Curtis announced that the report was before the meeting for discussion, and the subject was discussed by Messrs. Onward Bates, Gardner S. Williams, S. Everett Tinkham, Robert A. Cummings, Edgar S. Nethercut, John L. Hall, J. W. Alvord, Richard L. Humphrey, George F. Swain, L. D. Rights, W. H. Woodbury, Clarence Blakeslee, Hunter McDonald, C. F. Loweth, T. C. Hatton, A. F. Blaser, J. A. Ockerson, Chas. Warren Hunt, G. C. Mason, Charles Hansel, George G. Anderson, O. H. Dickerson, and A. N. Talbot.

The Secretary read a telegram* from Fraser S. Keith, Secretary of the Engineering Institute of Canada, who, with Brig.-Gen. Sir Alex. Bertram, Member of the Council of the Institute, had been invited to attend the Convention.

Adjourned.

ELECTIONS AND TRANSFERS BY THE BOARD OF DIRECTION, JUNE 16th, 1919

Elected as Members

Neil Stanley Buckbee, Buffalo, N. Y.
Walter Dennis, Moberly, Mo.
Joseph Hoover Fichthorn, Philadelphia, Pa.
Arthur Jay Grier, Oakland, Cal.
Andrew Harkness Harkness, Toronto, Ont., Canada
Peter Junkersfeld, Washington, D. C.
Edward Joseph Kelly, Chicago, Ill.
Judson Huntoon Merriam, Bridgeport, Nebr.
Albert Arthur Miller, Kansas City, Mo.
Frank Arthur Rapp, Seattle, Wash.

Elected as Associate Members

Peter Thornton Barrett, Washington, D. C.
George Whitney Bates, Lincoln, Nebr.
Frederick Max Beer, Brooklyn, N. Y.
George Adam Bengel, Springfield, Ill.
Charles Arthur Bissell, Washington, D. C.
Alexander Watt Blyth, Jersey City, N. J.
Frank Marvin Burr, Owensboro, Ky.

* See page 573.

Charles Chambers, Calgary, Alberta, Canada
Frank Joshua Clark, New York City
Charles Henri Coeytaux, Sanchez, Dominican Republic
Grey Willis Curtiss, South Braintree, Mass.
John Albert Dalen, Springfield Gardens, N. Y.
Robert Clark Dennett, New York City
Raymond Duerr, McGregor, Iowa
Charles Elcock, Philadelphia, Pa.
Richard Ellis, Boston, Mass.
Nathaniel Finestone, Minatitlan, Mexico
Andrew Fischer, Jr., Bloomfield, N. J.
Walter Arthur Fischer, Washington, D. C.
Charles James Folk, Phillipsburg, N. J.
Robert Lee Fox, Bethlehem, Pa.
Herbert Morgan Gallagher, Meridian, Miss.
George William Gates, New York City
Orval Lee Gearhart, Dixon, Ill.
John Glaettli, Jr., San Diego, Cal.
Grover Cleveland Green, San Francisco, Cal.
E. Ray Griffin, Mandan, N. Dak.
Roscoe Conkling Ham, Kansas City, Mo.
Kenneth Harrow Hanger, El Dorado, Ark.
Harwood Syme Haynes, Washington, D. C.
Peter Leo Hein, Chicago, Ill.
John Henry Hession, Cambridge, Mass.
Preston Thomas Hicks, Decatur, Ill.
Arthur Beers Hitchcock, Kansas City, Mo.
Frank Warne Hoff, Pittsburgh, Pa.
John Thomas Hopkins, New Brunswick, N. J.
John Wallace Johnston, Parkersburg, W. Va.
Geary Kimbrell, Pendleton, Ore.
Edward Leech, Jamestown, N. Y.
Nathaniel Morris Liddell, Topeka, Kans.
Nelson Johnson Lomax, Kansas City, Mo.
DeMont George Miller, Los Angeles, Cal.
Arthur Herbert Morrison, Boston, Mass.
Francis Barnard O'Connor, New York City
Scott Wesley Orr, Chelsea, Mass.
Olaf Otto, Savannah, Ga.
Charles Arthur Patterson, Torrington, Conn.
Earl Frost Reagan, Akron, Ohio
Clifton Rice, Richmond, Tex.
Joseph Michael Roeschlaub, Brooklyn, N. Y.
Hugh Rayner Seabrook, London, England

Jacob Ralph Shank, Columbus, Ohio
Kirpal Singh, Jethuwal, India
Adrian Clyde Stanfield, Pana, Ill.
Benjamin Stein, New York City
Ernest Elba Swope, Beaumont, Tex.
Luther Rudolph Tillotson, Topeka, Kans.
Roy Ollin Walker, Chicago, Ill.
Richard Parker Wallis, New York City
Lloyd DeWitt Walter, Omaha, Nebr.
Ralph Theodore Wenstrand, Omaha, Nebr.
Timothy Silas Williams, New York City
Lef Winship, St. Louis, Mo.
Clyde Warren Wood, Oakdale, Cal.
John Young, Brooklyn, N. Y.
Vratislav Adolph Zehr, Pekin, Ill.

Elected as Associates

Ford Ashman Carpenter, Los Angeles, Cal.
William Clark Irwin, St. Louis, Mo.
Frank Rabold Walker, Chicago, Ill.

Elected as Juniors

Harry Lewis Bayer, Temiskaming, Que., Canada
Michael Joseph Burke, Indianapolis, Ind.
Frederick Conrad Gamsu, New York City
Gene Bryant Heywood, Pasadena, Cal.
Joseph Jaromir Kuchar, Muscle Shoals, Ala.
Benjamin Levey, Middleboro, Mass.
Byron Casper McCurdy, London, England
Edwin Newburger Seymour, Am. Exp. Forces, France
Claude Wellington Sopp, Pasadena, Cal.
Missac Thompson, New York City
Paul Amos Vickers, Kansas City, Mo.

Transferred from Associate Member to Member

Robert Edward Barrett, Turners Falls, Mass.
Lyman Edgar Bishop, Denver, Colo.
Eugene Bradford Bumsted, Berkeley, Cal.
John Wesley Cornell, Washington, D. C.
John Kramer Flick, Baltimore, Md.
Charles Edward Gilman, Oakland, Cal.
Luke Joseph Hayes, Niagara Falls, N. Y.
Alfred Brackenridge Heiser, Brooklyn, N. Y.
John Strider Hess, Chicago, Ill.

Alberto Angel Ibarguen y Pi, Pinar del Rio, Cuba
Robert Hyde Jacobs, New York City
John Monroe Johnson, Marion, S. C.
John Edward Kirkham, Ames, Iowa
Eugene Clyde La Rue, Pasadena, Cal.
Charles Hamilton Lee, Berkeley, Cal.
John Henry Madden, New York City
Grover John Meyer, St. Lambert, Que., Canada
George Edward Pellissier, Springfield, Mass.
Edgar Kingsbury Ruth, Cincinnati, Ohio
Curlys Lyon Slocum, Springfield, Mass.
Leslie Wrightson Stocker, San Francisco, Cal.
Samuel Wright Tay, New London, Conn.
Benjamin Thomas Weston, Temiskaming, Que., Canada

Transferred from Junior to Associate Member

Benjamin John Curtis, Blue Island, Ill.
Charles Edmund De Leuw, Chicago, Ill.
Roland Russell Graham, Philadelphia, Pa.
Phillip Wheeler Kniskern, Chicago, Ill.
Sydney Bishop Lamb, Denver, Colo.
William Durkee Smith, Tacoma, Wash.
George Albert Tilton, San Luis Obispo, Cal.

OF THE BOARD OF DIRECTION

(Abstract)

June 16th, 1919.—The Board met at 10 a. m., at the Hotel Radisson, Minneapolis, Minn., at the time of the Annual Convention, as required by the Constitution; President Curtis in the chair; Chas. Warren Hunt, Secretary; and present, also, Messrs. Alvord, Crocker, Darling, Elwell, Flinn, Grunsky, Hawgood, Ketchum, McDonald, Metcalf, Pegram, Rights, Talbot, Tuttle, and Wagner.

A report* from the Finance Committee was received, and the appropriation recommended for the re-cataloguing of the Engineering Societies Library ($2 500 for the current year), was approved.

A report† from the Library Committee was received, and after a discussion of the question of the ownership of the books in the Engineering Societies Library, the following resolution was adopted:

"Resolved: That the Board of Direction of the American Society of Civil Engineers recommends to United Engineering Society that suitable legal steps be taken to transfer to United Engineering Society the legal title to all books in the Engineering Societies Library now owned by the several Founder Societies."

* See page 681.
† See page 683.

A report from the Publication Committee was received.

The Secretary reported the result of the canvass of the ballot on changes in the "Year Book" and the omission of "Changes of Address" in *Proceedings*,* and the Publication Committee was instructed to carry out the result of this ballot.

A report† from the Committee on Special Committees was received and adopted. This report included the discharge, at its own request, of the Committee on Reconstruction; the appointment of a Special Committee on Highways, etc.

By invitation of the Board, Past-President Onward Bates, Chairman of the Committee on Development, presented the Second Progress Report of that Committee.‡

The following resolution was adopted:

"*Resolved:* That the Progress Report of the Development Committee be received and ordered presented to the Business Meeting of the Convention, in printed form if possible, and subsequently forwarded to the entire membership and to each Local Association of Members, with the request that the benefit of individual or collective opinion on any or all fundamental points be communicated to the Chairman or Secretary of the Committee."

It was moved, seconded, and carried:

"That the Committee on Development be authorized to hold an additional meeting, in order to prepare a further report to be in the hands of the Secretary of the Society by November 1st, 1919, so that it may be issued to the membership sufficiently in advance of the Annual Meeting to insure a thorough discussion of it at that meeting."

Mr. Bates stated that, at the request of one of the members of the Executive Committee of the Committee on Development, he asked the Board for the privilege of adding certain explanatory matter which should also be printed and sent out to the membership with the report of the Development Committee.

Mr. Bates' request was granted, and the following resolution was adopted:

"*Resolved:* That the Committee be authorized to add such explanatory matter to the report and print it and send it out with the report as may meet with the approval of the Chairman of the Publication Committee."

A motion to the effect that Mr. Bates be requested to continue as Chairman of the Development Committee was unanimously carried.

Adjourned 1 P. M.

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* See page 550.

† See page 685.

‡ See page 589.

The Board reconvened at 8.10 P. M., on the adjournment of the Membership Committee; President Curtis in the chair; Chas. Warren Hunt, Secretary; and present, also, Messrs. Alvord, Crocker, Darling, Elwell, Flinn, Grunsky, Hawgood, Ketchum, McDonald, Metcalf, Pegram, Rights, Talbot, Tuttle, and Wagner.

A report was received from the Committee appointed by the President to confer with similar committees of the other National Engineering Societies and to report on the formation of a Franco-American Engineering Committee, its scope and purpose, manner of operation, etc., with recommendations, and on motion, duly seconded, the report was adopted, and the Committee continued.

The Secretary reported that Messrs. George S. Webster, H. H. Porter, and A. Marston had accepted appointment as representatives of the Society on the Engineering Division of the National Research Council; that Robert A. Cummings had accepted appointment to represent the Society on the American Welding Society; and that Messrs. Albert S. Crane, Ralph Modjeski, and Arsène Perrilliat had accepted appointment as a Committee to Recommend the Award of Prizes for this year.

Francis R. Weller, M. Am. Soc. C. E., was asked to represent the Society at a public conference on business training for engineers and engineering training for students of business, to be held in Washington, D. C., on June 23d-24th, 1919.*

The following resolution which had been adopted at an informal conference of the Presidents and Secretaries of the Founder Societies held on April 29th, 1919, was presented:

"Whereas: Requests for funds for various joint activities of the Founder Societies, are received from time to time after the Societies have adopted their annual budgets; and

"Whereas: Prompt and harmonious action upon such requests is desirable for effective co-operation,

"Voted: To recommend to the governing bodies of the four Societies that a Founder Societies' Finance Committee on Joint Activities be appointed, consisting of two representatives from each Founder Society, one of whom shall be the Chairman of the Society's Finance Committee, and that to this committee shall be referred for consideration and recommendation, before action by any of the governing bodies, all requests for finances for joint activities."

On motion, duly seconded, Nelson P. Lewis, Chairman of the Finance Committee, and Chas. Warren Hunt, were appointed to represent this Society on the Founder Societies Finance Committee on Joint Activities.

Upon the request of United Engineering Society for an additional appropriation of $6 000 for the use of the Engineering Societies

* See page 698.

Employment Bureau, the Treasurer and Secretary of the Society were authorized, the other Founder Societies concurring by similar action, to commit the Society to an expenditure not exceeding $1 500 for the use of the Engineering Societies Employment Bureau, in addition to previous appropriations through Engineering Council for the present calendar year.

The following resolution was adopted:

"*Whereas:* The question has been raised as to the right of a Trustee of United Engineering Society, appointed by the Board of Direction of the American Society of Civil Engineers, to vote in accordance with his own views and in opposition to the directions of this Board.

"*Resolved:* That the representatives of this Society on the Board of Trustees of United Engineering Society are subject to the instructions and must reflect the will of this Board in all matters when such will has been officially expressed and communicated to them.

"*Resolved, Further:* That a prompt expression of the intentions of each of the present Trustees with respect to this matter is requested."

The following resolution was adopted:

"*Resolved:* That a Committee consisting of the five latest living Past-Presidents, the President, and the four Vice-Presidents, be appointed to nominate for election to the grade of Honorary Member such persons, not more than seventeen in number, as they may unanimously agree upon, who, under the Constitution, may properly be credited with this distinction."

The resignations of 3 Juniors (one effective December 31st, 1919) and 1 Associate Member were accepted.

Ballots for membership were canvassed, resulting in the election of 10 Members, 66 Associate Members, 3 Associates, 11 Juniors, and the transfer of 7 Juniors to the grade of Associate Member.

Twenty-three Associate Members were transferred to the grade of Member.

Applications were considered and other routine business transacted.

Adjourned.

FORTY-NINTH ANNUAL CONVENTION, HELD IN ST. PAUL AND MINNEAPOLIS, MINN., JUNE 17th-20th, 1919.

FIRST SESSION

Tuesday, June 17th, 1919.—The first session of the Annual Convention was opened in the Gold Room, Mezzanine Floor, of the Radisson Hotel, Minneapolis, Minn., at 10 A. M.; R. D. Thomas, M. Am. Soc. C. E., President of the Northwestern Association of Members of the American Society of Civil Engineers, and Chairman of the Local Committee of Arrangements, in the chair; Chas. Warren Hunt, Secretary; and present, also, about 200 members and guests.

THE CHAIRMAN.—Ladies, and Members of the American Society of Civil Engineers: The local members of the Society welcome you to-day. We have been waiting a long time for this pleasure, in fact, for two years. A little more than two years ago, we were informed that we were to have the pleasure of entertaining you in June, 1917. We made our arrangements, but before they were consummated, the war came on, and, as you all know, that meeting was postponed, and this is the first summer convention held since that time. On the programme for that occasion, we had the Governor of Minnesota down for the address of welcome. We have given him two years to prepare that speech for you. I now take great pleasure in introducing Governor John A. A. Burnquist.

GOVERNOR BURNQUIST.—Members of the American Society of Civil Engineers: It is an unusual pleasure for me to extend to you the cordial welcome which I offer on behalf of our State. I wish it were possible for us to show it to you as we would like to, and for you to view its 10 000 beautiful lakes, its winding streams, and wooded hills. I wish it were possible to take you over our 20 000 000 acres of agricultural lands on which are growing our immense crops, and also our 30 000 000 acres not yet under cultivation, but which we hope will be before many years have passed, through the services of the engineers of this State and nation.

I see by your programme that you are to visit the north-eastern section of our State. I hope that you will all be able to go, for there you will find men digging down into the depths of the earth, taking out of it a mineral which is being manufactured into products that are marketed throughout the length and breadth of the United States and of the world.

We, in this State, like to boast of what we have, just as men everywhere like to boast of whatever State, territory, or community, in which they live. Not long ago, I was down in Kansas, and the people there seem to be quite boastful about Kansas. While there a college president

told me of an incident which may interest engineers. On one occasion, two or three men were sitting chatting together on a railroad train, and each was boasting at considerable length about the wonders of his particular community. One of them was especially enthusiastic about his home city, and said that all it needed to make it one of the greatest cities in the country was a seaport. "Well," said a man in the seat in front of them, "you will have no trouble in getting a seaport. All you have to do is to lay a pipe line to the Gulf of Mexico, and if you are as good at sucking as you are at blowing, you will have no trouble in getting a seaport."

We all like to boast of our respective Commonwealths; we all like to boast of the particular community in which we live; but I am sure that, proud as we are of our different States and Territories, we take still greater pride in our common country—the United States of America.

To-day as we are gathered here from different States and Territories all of us rejoice in the fact that, regardless of where we have come from—whether from the Pacific slope or the Atlantic coast, north or south—we live in a united country, under a government which is back of our States and back of all our institutions, where we feel that the people of the whole of the United States are the real power and the real sovereignty.

So we of Minnesota, one of the many States of the Union, welcome you here. We are glad to have you with us and know that while you are here, your conferences will be of benefit not only to your Society, but to our own State and to our beloved, common country. During the recent war you did much in connection with serving your country. I understand that one-sixth of your membership was in the service of the nation at that time. This number constituted more than 1 500 of your 9 000 members. They fought for the advancement of the ideals of the American Republic, and were men of skill and genius, who were not working for that selfish ambition for which our enemies were struggling. Their ideals were entirely different from those of the European warlords, who were striving for the gratification of their own selfish ambition and were willing to sacrifice on the fields of battle thousands of innocent victims, regardless of the rights of their fellow men.

By reason of the winning of the war, I believe we are entering on a new era in your profession; that is also true of other professions, of other lines of business, but it is especially true, I believe, of the Engineering Profession. Thirty-six years ago, this Society had a meeting in Minneapolis, and those of you, if any, who were here at that time, will realize the progress Minnesota has made during those 36 years. We are going to advance still further. We feel there is no limit to the aspirations of men. No sooner is one high aim attained than others appear in view to be sought for and worked for. No sooner do we climb one mountain peak than we find ourselves gazing at others in

the distance. Let us all continue to strive onward and upward, working to make this, as it is now and shall continue to be, the greatest nation in the world.

THE CHAIRMAN.—I wish to say that Governor Burnquist is an Executive who appreciates engineers. During his administration, he has shown this by appointing them to serve in different capacities. We all appreciate it and are doing what we can to see that he makes good appointments.

President Curtis needs no introduction to the members of this Society. I take great pleasure in stepping aside that you may enjoy listening to him.

President Curtis presented the Annual Address.*

THE SECRETARY.—Mr. President, I have the following telegram of regret from Horace V. Winchell, President of the American Institute of Mining and Metallurgical Engineers, who was to have addressed the meeting on "The Mines of Minnesota:"

"BUTTE, MONT.
"CHARLES WARREN HUNT,
"29 West 39 St., New York, N. Y.

"Much regret that western engagements prevent my addressing Civil Engineers in Minneapolis June seventeenth.

"H. V. WINCHELL."

F. C. Shenehon, M. Am. Soc. C. E., delivered an address on the "Engineering Activities of the Twin Cities."†

Adjourned.

SECOND SESSION, BUSINESS MEETING

Tuesday, June 17th, 1919.—The meeting was called to order at 2 P. M.; President Curtis in the chair; Chas. Warren Hunt, Secretary; and present, also, about 220 members and guests.

THE PRESIDENT.—The Secretary will please read the result of the ballots on the proposed changes in the "Year Book", and the omission of "Changes of Address" in *Proceedings*.

The Secretary read the report, as follows:

"33 West 39th Street,
"New York, N. Y.,
"June 4th, 1919,

"TO THE BOARD OF DIRECTION:

"The undersigned appointed by the Chairman of the Publication Committee as teller to canvass the ballots on:

No. 1. Changes in 'Year Book',

No. 2. Omission of 'Changes of Address' in *Proceedings*,

reports as follows:

* See page 437 of Papers and Discussions.

† See page 580.

"Total number of ballots received	2 278
"Ballots without signature	19
"Ballots canvassed	2 259
"No. 1. Changes in 'Year Book':	
Yes	1 920
No	327
Not voting	12
"No. 2. Omission of 'Changes of Address' in *Proceedings:*	
Yes	1 831
No	417
Not voting	11

"Respectfully submitted,

"CHAS. WARREN HUNT,
"Secretary."

THE SECRETARY.—Mr. President, I wish to announce the election and transfer of candidates by the Board of Direction on June 16th, 1919.*

(On motion, duly seconded, the reading of the list of candidates was omitted.)

THE PRESIDENT.—The next in order will be the reading of the Report of the Development Committee.

The Secretary read the Report of the Development Committee.†

THE SECRETARY.—Mr. Chairman, I may say that this report was presented to the Board of Direction which adopted a resolution to the effect that it should be presented to this Business Meeting of the Society, and that it should be printed and forwarded, at the earliest possible moment, to every member of the Society and to all the Local Associations, with the request that, individually or collectively, any information, opinion, or discussion of the points brought out in the report be communicated to the Chairman or the Secretary of the Development Committee, in order that the Committee may be able to formulate a report to be placed in the hands of the Secretary, under the constitutional limitation, on or before November 1st, 1919. This further report—perhaps final and perhaps not—may then be sent to the entire membership of the Society in sufficient time in advance of the next Annual Meeting, to enable those present at that meeting to discuss it with a full knowledge of all that has been brought out.

THE PRESIDENT.—I want to say, Gentlemen, that the Secretary has correctly stated the situation, as I understand it. The report was submitted to the Board of Direction yesterday by the Chairman of the

* See page 541.

† See page 589.

Committee, who stated that it was practically tentative. I want to thank the members of the Committee for the work they have done in preparing this report; it is a very interesting one, but, as I have previously stated, not complete. The Board of Direction at its meeting authorized an additional outlay to pay for a future meeting of the Development Committee, in order that it may prepare a definite report to be submitted previous to the Annual Meeting. This report is now before you for discussion. I think there may be variance of opinion, and, as I have already said, the Committee does not consider it a final report. The Committee has been at work on it for a week and has made much progress. The Board of Direction has authorized it to be printed and sent out to the members of the Society in order to get their opinions to help the Committee in presenting a definite report to the Board previous to the Annual Meeting, when it will be considered.

A Member.—I notice a number of things in the report which are not in accordance with the Constitution. I do not see how they can be adopted without conforming to the Constitution.

The President.—I think the Committee understands that they cannot be adopted without changing the Constitution.

Onward Bates, Past-President, Am. Soc. C. E.—With regard to the specific question, and, generally, I wish to say something and get it off my mind. First, if I should happen to leave this meeting, I hope you will all understand it is simply and solely because the atmosphere in this room is such that it makes my head swim; it seems almost unbearable to spend an hour here. I feel a little dizzy now.

Now, Mr. President and Gentlemen, with regard to this report: Speaking as Chairman of the Committee, I will say that with a committee of twenty-eight, scattered in many directions, it was almost impossible for the Chairman to perform any other duty than that of administrative officer, and he has only fulfilled that office by having a most capable and willing Secretary to do the work. Therefore, when you come to the details of this report—there are a great many of them —I hope, for the sake of humanity, you will not undertake to discuss them all to-day. When it comes to those details, however, I will say that the men who actually did the work on the report know more about it than the Chairman. I am sure that the Chairmen of three of the Sub-Committees are present, and those who took the most active part in the preparation of the report, with a few exceptions, are also in this audience, and, Mr. President, it will be a great deal better to get the information in detail from those who wrote it and presented it at the joint meeting of the Committee.

The President.—I will call on Mr. Gardner S. Williams.

Gardner S. Williams, M. Am. Soc. C. E.—Mr. President, to my mind the essence of this report can be summed up in a very few words.

First, in regard to our internal affairs: We propose that the members of the Board of Direction shall be elected by the corporate members in the districts which they represent. The only way in which we have been able to think of bringing that about is by making every member of the Society a member of a local association, and then by affiliating those associations in the districts by some form of organization that will assure to every member in the district an opportunity to make himself heard in the selection of the members of the Nominating Committee and the Board of Direction from that district. We have not gone into the full details of that organization. We send the thought out to learn whether or not it is agreeable to you. And, obviously, if every member of the Society is to be a member of a local association, then a portion of the dues which he pays to the National Society should go back to the local association in order to provide for its expenses. So that, so far as this Society and the other National Societies are concerned, they should continue, as in the past, to devote their energies chiefly to the technical affairs of engineers as engineers. We say, however, that there should be formed a general organization of engineers to take in all engineers, and we begin at the bottom: We say to our local associations, get together with the local associations of other Societies; and to our associations and the local associations of other Societies, get together with the engineers' societies of your localities, wherever you are, and if there are any scattering engineers not connected with any society, get them into a general local organization for the purpose of bringing their influence to bear in civic affairs. And we say to those local organizations or affiliations, as we have called them, get yourselves together in a State organization, by delegates, or otherwise. And then we try to form a National council, composed of representatives of the National Engineering Societies as such, and of representatives of the State organizations to which we have just referred, either as State organizations, or as individual societies or groups of societies, as the members may decide.

In brief, those are the two main points of this report. It also emphasizes the fact that the engineer should participate actively in civic affairs in his community. That has been said so often, that it is almost too trite to repeat, but we have put it on record once more.

To summarize, the proposal is to affiliate all engineers in a way similar to that already in effect for furthering a National Department of Public Works, and I may say in passing that an Act is already drawn to create such a Department, in which there shall be assembled all the engineering activities of the General Government, which legislation should have the active support of every engineer.

I have presented what, to my mind, are the main issues of this report. The rest is necessarily more or less detail. We realize that changes in the Constitution must be made, but before we start to

make them, it is the thought of the Development Committee that the issuance of a series of questions covering the points which we have taken up, or will take up in our final report, questions submitted to the membership of the Society, will bring out statements and opinions which will enable us to ascertain whether or not the membership is willing to follow us in the proposals we have made. If not, we, or some other development committee, should start over again and formulate a programme which the members are prepared to follow. I thank you.

THE PRESIDENT.—I would like to ask Mr. Tinkham if he has anything to say.

S. EVERETT TINKHAM, M. AM. SOC. C. E.—Mr. Williams has covered so fully the work of the Committee and given in a brief and condensed form, what the Committee had in mind in preparing the report, that I do not think I can add any information of importance at this stage of the discussion. What the Committee desires is the opinion of the members on the preliminary report now before them.

ROBERT A. CUMMINGS, M. AM. SOC. C. E.—Mr. President and Fellow Members of the Society: Perhaps I may supplement the remarks of Maj. Williams by referring to technical development.

Our Society is exclusively a technical organization and in the past has been administered as such. Superior technical work requires that its activities remain in control of the older and more experienced members of the profession. Therefore, whatever development or extension is proposed must require this control as its fundamental feature.

On the contrary, the Development Committee has submitted to you the proposal (and it has met with encouragement) that the activities of the Society should be extended into welfare work and to the National domain of public endeavor. For this purpose, the basis for organization and administration must be placed in control of the rank and file of the members of the profession.

The report is a harmonizing of these two principles in a single organization, by adopting fundamentals to govern the development for any future scheme of organization.

The idea of the Technical Sub-Committee is that there shall be no relinquishment of our technical position, but rather an effort to improve and extend our activities into neglected fields, research, etc. The common ground on which we are brought together in this Society is that of mutual technical interests, and these must be maintained.

THE PRESIDENT.—Is Mr. Darling present?

THE SECRETARY.—I suggest that Mr. Nethercut, the Secretary of the Western Society of Engineers, and a member of the Committee on Development, give us his ideas.

Edgar S. Nethercut, M. Am. Soc. C. E.—In considering the work of the Committee on Development, I believe that we are ready, at this time, to submit what might be called a proper cross-section of our views. The first meeting of the Committee did not develop ideas in a sufficiently clarified form to make them worthy of presentation. We now have before us in this report many things which a number of our members will be glad to see. It may present some things which we are not now ready to accept, and further discussion and enlightenment by the membership will enable the Committee to draw up a final report. The methods of organization proposed have been sufficiently outlined to make them clear.

It is clearly set forth in the recommendations that the American Society of Civil Engineers shall continue to be, as it has for the last sixty years, the pre-eminent standard for the Engineering Profession and practice. This should not be neglected, and cannot be omitted, if we are to succeed. The one thing that impresses me with regard to this report is, that however fine a plan of machinery we may set up for the organization of the American Society of Civil Engineers, unless that machinery is propelled by the spirit of service and co-operation on the part of every member, it will be futile.

I am sure we all agree that this report is progressive. I am impressed with the earnest manner with which it is received. The spirit of service must be maintained, and the opportunity now presented in a larger way than ever before, will enable every member of the Society to participate fully in its affairs. This means that the present generation will have a like opportunity as generations which have gone before, who did not render service, and by so doing be an inspiration to us all; in fact, even greater opportunities are now presented to our members.

The President.—I would like to call on the representative from the Pacific Coast, Mr. Hall. Is he present? If so, will he please come forward?

John L. Hall, M. Am. Soc. C. E.—I do not feel it essential that I should come forward, because I feel very strongly that the Committee on Development would rather hear from the membership present than otherwise. I think so far, the subject has been well covered and developed. I can only say to you, since I have been called forward as a representative from the Pacific Coast, that we, of the Coast, are heartily in accord with the report of the Committee. The representatives from the Coast—and there are a number—have worked hard and come a long way, and we are entirely satisfied and pleased with the result.

I think that we all would like to hear more from the representatives here personally—from the membership of the Society as a whole—particularly we of the Coast. We are so scattered out there that it is

difficult for us to know the feeling of the membership. The organization of a local association has given us an opportunity to get together and crystallize our views, but we remember that we are in the minority and that the views of the majority must prevail. Speaking, therefore, for the Coast, I repeat that we would like to have an expression from the membership here present, who are not members of the Committee on Development.

THE PRESIDENT.—I have called on one or two members of the Committee, because I wanted those present to get an idea of what the Committee has done, and the reasons for it. As I told you in the beginning, this whole matter is to be submitted again for final action. The Board of Direction has ordered this report printed and issued immediately, in order to get suggestions for the Committee, so that it may revise them or revise the report, as it sees fit. I think it would be wise to hear from any one who desires to say anything on the subject. The matter is now practically open for discussion. We would be glad to hear from any one who desires to say anything in the matter.

JOHN W. ALVORD, M. AM. SOC. C. E.—As one of the original Bolshevists who started the idea of the Development Committee, I am pleased with its report. Secretary Hunt says that, "a Bolshevist is a man who wants something, but does not know exactly what he wants." I think, perhaps, in Society matters I can qualify under that definition.

We are all greatly impressed, since the war, with the tremendous impetus given to the Profession of Engineering, by the great engineering need of the Government and its call to the engineers of the country and their splendid response. We all feel that the time has come when this country should know more about the Engineering Profession, and that the Engineering Profession should take a more advanced place than ever before. When we undertake to make some concerted move, however, we find that the Engineering Profession is divided into different technical activities which seem to develop into vertical cleavages, and we also find that it is much divided into horizontal cleavages by societies for the young men, societies for the betterment of university professors, and societies for the promotion of various grades of activities of many kinds.

Now, I deprecate both these vertical and these horizontal cleavages, because I want to see all parts of the Profession united, so that the technical activities of this country are so welded together that we shall strongly and rightfully take the place in the nation which we should occupy for our service to the country's best good and for any call that the country may make on us; and I hope that this report of the Development Committee will be a long step in this direction.

In regard to two headings of this report, I find myself asking some questions; possibly it is premature to ask for too much detail at this time, yet I presume that we must feel our way along, and I suppose

that the Committee has felt its way along a little farther than the rest of us.

In reading the report, and noting the dual organization that has been proposed and which has been described by one of the speakers—the technical activity from the top down, and the welfare purposes from the bottom up—I do not see quite clearly how these two organizations work together in the higher National affiliation. I observe that we have the recommendation for the united local association and we have the recommendation for a State representation. Now, where does the technical society—presumably, we will say, in this case, the American Society of Civil Engineers—cease to function through the welfare purpose in its dues, its duties, and its elections? I would be very glad if some member of the Committee would make it just a little clearer to us.

THE PRESIDENT.—Mr. Alvord has asked a question. Does any member of the Committee desire to answer it?

RICHARD L. HUMPHREY, M. AM. SOC. C. E.—The line of separation between the two organizations is at the local association. In other words, the local association of this Society functions, through the district organization of the Society, in all administrative and directly in all technical matters with the Society; while in non-technical matters or welfare work, if you please, the local association functions with the local associations or sections of other National Engineering Societies, of the local engineering societies, and the local engineers, through the State organization to the National council. They are substantially two separate organizations, their only common point being the local association of the members of this Society for carrying on its technical work, which local members co-operate with the members of other local associations or sections of the National Engineering Societies, of the local engineering societies, and the local engineers, in forming the local group or affiliation for carrying on welfare work. The Society is interested in this welfare work at the bottom through its members in the local affiliations, and at the top through its direct representation on the National council.

MR. ALVORD.—Then the National organization is the great society of all societies—as distinguished from the American Society of Civil Engineers which claims to be the technical society in civil engineering matters?

MR. HUMPHREY.—Yes. Except, it should be clearly pointed out, that the National Engineering Societies are interested in welfare work for the engineer, and will exercise a restraining influence on the National council through their representation on it.

THE PRESIDENT.—Is there any one else who cares to discuss the matter at present? As I told you in the beginning, I understand from the Chairman of the Committee that this is just a tentative report. It

is a very good one, and one which the Committee was desirous of placing before the Board meeting yesterday; but there are many things which the Committee is anxious to have discussed—for use at further meetings—and this discussion will help the Committee.

George F. Swain, Past-President, Am. Soc. C. E.—I have only read this report once, or rather listened to it, and I do not like to discuss a thing without more careful consideration. I am very pleased with the report, however, and thoroughly in sympathy with almost all of it. With all the big things in it, I am entirely in sympathy, so far as I have had time to consider them. There were, however, two or three little things that occurred to me, as I listened to it, which it may be worth while to mention. The first is with reference to licensing engineers. That paragraph provides that the Society, in co-operation with other societies, prepare a standard form of bill for the licensing of engineers, "to be used in the framing of legislation." Now, I have no objection to a standard form of bill; but when it says "to be used in the framing of legislation", that seems to me clearly to imply that this Society favors and intends to advocate and promote such legislation, and, up to the present time, I have been against the licensing of engineers. If we are to be licensed, there ought to be a proper bill, but it seems to me that we are not ready to advocate this, and that the report should read, "to be used in the framing of legislation if necessary", or something of that kind. I submit that for the consideration of the Committee, because it seems to me that the present wording implies directly that this Society favors the licensing of engineers.

The second thing that occurred to me was something of a similar character—in regard to legislation and the development of natural resources. It says that the National council shall maintain an agency, etc., so that proper legislation may be enacted. That is all right; but there is another thing more important than that, and, that is, that improper legislation shall be defeated. There is much more danger, it seems to me, in this country at the present time, from improper legislation being enacted, than there is of not enacting proper legislation. We have too much legislation, I think. I am a great believer in letting things work themselves out. I think this idea ought to be brought in somewhere, to the end that not only proper legislation may be enacted, but that improper legislation may be defeated.

The third item was in reference to the code of ethics to be prepared. I think a code of ethics, if intended to be enforced, is usually negative, and that is the proper way. I think the council would find it difficult to get a short positive code—a short code which would cover all the things a man ought to do. You can get a much shorter code if you will lay down a few general principles or things he ought not to do. A code of ethics may be a good deal of a farce, any-

way, if it simply consists of positive generalities. You have got to assume that a man has moral character, that he can recognize what is right without having it put down on paper; and if he cannot do that, no code will do him any good. It would be much better to state clearly the things a member of the Society ought not to do, and I think it would be rather demeaning to the Society to try to lay down a statement of all the things its members ought to do. Such a list would naturally include a great many things that every one would know he ought to do, and what is the use of putting them in? There is a contradiction between a "short code" and a code of "positive character." Personally, I think the present code of ethics is a good one, if it is made clearly enforceable, so that if a man violates it, he may be punished.

L. D. Rights, M. Am. Soc. C. E.—This report provides for a great extension of the activities of the Society. Article 1, Section C, recommends four meetings each year of the local associations, and provides for four general meetings a year of the Parent Society, as against the present two. There is a provision for increase in the publications, for abstracts from engineering articles, and for a technical staff under the direction of the Publication Committee. Probably all these things can be carried out at the present time under our present Constitution. The one important point which occurs to me is that we cannot do these things unless we have more money, and I would like to ask the Committee how it proposes to get the money. You know our annual dues are fixed by the Constitution at $15 for members outside of District No. 1 and $25 for members resident in that District. There is a move in the New York District to form a local association, and to request the Board of Direction to change the Constitution so as to make a change in the dues. In other words, the local association in the New York District proposes that its members pay for its meetings, just as the local associations in other places pay for their meetings, and that there will be no difference between resident and non-resident dues. As a suggestion, you know that the dues have not been changed for 20 years, but almost everything else has advanced to after-war prices. What would you think of raising the dues throughout the whole country to $25? The only other way that I know to get the money to carry on these activities would be possibly to go into matters more commercially in the publications; the Publication Committee has had under consideration the question of adopting advertising in order to get money to carry on our various technical activities. We do not know how the Society or the Development Committee will receive this, but I bring it before you for your consideration.

W. H. Woodbury, M. Am. Soc. C. E.—I want to commend the Committee on its report. I think it is a magnificent move forward.

That this Committee has made such a move forward, brings to my mind a fact that we should not overlook; it is a representative Committee.

Under (g), on page 4 of the report, it speaks of having an annual conference of delegates. This Committee has perhaps done more for the advancement of our Society than any other one organization that we have had in years, and the very fact that it is composed of representatives (with a few exceptions) is proof that this is a very valuable principle of organization, and I cannot see why we should not perpetuate this principle and make a similar body the governing body. We have a Board of Direction which is too large for an executive body and too small to be representative. To my mind the quickest way to get action and representative government is by making this a feature of our organization and cutting out a large part of our unwieldy machinery. Taking the suggestion (a), "That every member of the Society be a member of a local association", combined with the idea of a representative governing body, we have the ideal method of government. Every member should belong to a local association, and the local association have a representative. These representatives would come directly from the local associations and speak for them. That would be a government which would be directly in touch with every individual member. As it is now, it is impossible for our Board of Direction to be very definitely representative, and I think that this is a feature we should have.

Another thing I want to speak of is the matter of Society publications. The question in my mind is whether or not we should increase them very greatly, and, as a matter of purely a question to be asked, I would like to throw out the following for consideration. Compare our publications with any publication that is put "on its own" and made to be self-supporting, similar to our great technical magazines that must stand the test without artificial support. Let us think of our publications in that position. What would be the result if that were to be the test? I throw this out merely as a question.

Clarence Blakeslee, M. Am. Soc. C. E.—There is one thing in this Committee report that strikes me and, that is, the opportunities offered to the young men. When I was young, I wrote a paper, but when I took it to my partner, he said: "Well, Blakeslee, they won't want it—it won't do—the Society will never take it, and I don't blame them." If, however, the Society had taken that paper at that time, it would have done me a great deal of good. So I feel that the young men in our Society ought to have a chance. In this technical work we want good papers, and I want to appeal to the Board of Direction, and our Secretary, to give the young man—the young brother—a chance. If a young member has written a paper—even if it is a little long—slip it in, and it will do him a world of good.

THE SECRETARY.—I want to say one word regarding the code of ethics. I do not think that Professor Swain touched on the real thought about the code of ethics. Whether positive or negative, the really important thing about a code of ethics is the ability to enforce it. That is what this Society has not got.

PROFESSOR SWAIN.—I thoroughly agree with Mr. Hunt. I took it that was covered by another paragraph which provided for more effective means of disciplining and expulsion. I do not know whether that was so interpreted by the Committee.

MR. HALL.—May I say just a word on some of these less important affairs, Mr. Darling, Chairman of our Sub-Committee, not being here. This question of the code of ethics has been mentioned, and with it you may note what we say about the definition of the word "engineer." What is presented to you in the report is a specification for a code of ethics, and a specification for a definition. The Committee had a number of definitions, but it had not sufficient time to analyze them and bring them before you as its last word on that subject.

As to the code of ethics, I will say that there was a positive code submitted, conforming to the specification, and, on the first reading, it was adopted unanimously by the Sub-Committee. We had, however, a great many other data, and the report was becoming entirely too long. For that reason, the code of ethics was suppressed and a specification for one substituted. I hope the membership will deal with the code of ethics with an open mind when it comes to it.

HUNTER MCDONALD, PAST-PRESIDENT, AM. SOC. C. E.—I find myself in almost entire accord with what I read in this report. I have read it rather hastily, but I am somewhat familiar with some of the things in it, and I will reserve my remarks and criticisms for some more deliberate occasion and submit them in writing to the Committee, if I find that I do not tally with it in many respects.

I want to congratulate Past-President Talbot on his wisdom in selecting this Committee, and to congratulate the Committee on its splendid work. Several members of the Committee have asked me to give them the result of my experience with a local organization in a city where no previous organization of engineers existed—which is one of the problems to be confronted in any movement looking toward the unification of the profession. Personally, I am a strong believer in the power of the local organization. I think it should have autonomy just as far as possible. I am personally very much in favor of State organizations. I think the engineers of each State ought to be in a position to interest themselves in public affairs whenever necessary, and should have an organization through which to do it. I do not believe we can attain our best success in securing public recognition by placing members of our profession only in official positions. We have to travel a long road; we have to educate public sentiment up to

the point of recognizing the necessity for engineering and engineering advice in public activities. I think our professional engineering societies have failed to recognize one very important feature, in connection with the unification of the Engineering Profession, that is, that a very large body of competent and splendid engineers are not members of any organization. There are a great many of them, and when we seek unification we must remember that these engineers must be given something to attract them, in order to bring them into the organization.

I think the way we will get recognition as a profession is by the engineers—the men who call themselves engineers and have the right to do so—associating themselves together in every community where there are ten or twelve, and assuming a position in the community which will induce the public to have confidence in them and feel that they have no axes to grind and no ulterior motives, but that they will, as far as they can in a general way, advise the public with regard to local affairs. The public does not take that kind of advice very kindly, because you cannot arouse public opinion on any matter until the people are confronted with a calamity. It is the duty of the Engineering Profession to endeavor to prepare and educate the public before the calamity occurs. I do not mean that engineers should go into detail and undertake to work out problems free of charge to the civic body or the State; but they should try to secure, in the community in which they live, and in their State, the confidence of the public to the extent that the people will at least feel that if they are taking their advice, they are going in the right direction.

I would call the attention of the Committee to the excellent methods pursued by the International Rotary Club, of which I am a member. A strong feature of its hold on its membership and the public, wherever branches are located, is the noon-day luncheon. Adopting that plan in our community two or three years ago, we became associated with the Commercial Club, not under their orders, but under the same roof. We have given that Club to understand that we are there to serve it as a body, and we have been called on many times to do so, and have done it. We have a membership of about 125, and the average attendance at luncheon is about 25. Our programme, usually consists of committee reports and discussion of non-technical matters. Once a month we have a technical paper with discussion. We have standing committees on various subjects, and we require reports from them from time to time; and if they do not report, a new committee is appointed. We feel that our organization is gradually winning the public confidence, and that we are now in a position to do much good.

I throw this out as a suggestion that may be valuable in those communities where there are no sections of the National Engineering Societies. Where sections of the National Engineering Societies already exist, I am not very familiar with the problem; but it is a

problem, and it can be solved, and your Committee must find a way to solve it. The thing we must avoid is that which has separated our churches in all the communities—the endeavor to push the propaganda of each particular organization. Our effort must be to unite them, and, in that way, to unite the Profession.

C. F. Loweth, M. Am. Soc. C. E.—I had only a few minutes to peruse this report before coming here, and I was very well pleased with it. I congratulate the Committee on being able to put forward such an excellent report in so short a time. However, there have been some matters in connection with its discussion from the floor, which make me feel practically that the Committee in this report says one thing and that some of its members, in their minds, have another thing in view.

We have heard this afternoon—and I have heard many times in the past—the emphasis laid on the statement that the National Societies are technical societies; that they have never done anything else and are not organized so that they can do anything else, and that the welfare work, so-called, of the Engineering Profession must come from other sources. That does not seem to me to be a correct analysis. The American Society of Civil Engineers has done a great many things in the line of welfare work for engineers. The American Society of Civil Engineers adopted several years ago an admirable code of ethics. It has standing committees that have done good work, and, through the efforts of those committees, very noble work has been done in respect to engineers. Several years ago—referring to the licensing of engineers—a bill was prepared which at that time was, and perhaps is now, the best bill for licensing engineers in existence. We may not all agree that there should be licensing; but if there is to be a bill, that which this Society fathered and put forth is well worth the attention of engineers. In many other ways, this Society has stood for things, not only for the technical advantage and interest of engineers, but for their welfare. Now this Society is part and parcel of the engineering organization, an engineering organization which has been standing for a great many things that pertain to the welfare of engineers. It may be that in the past this Society and the other societies—the National Societies—have not done as much along this line as they should. We all feel at times that we are not doing what we would like to do. Every one who belongs to a club, or a church, or any organization, at times feels that perhaps the organization is not doing what it should; but we rarely go out and organize something else to accomplish what is desirable through the means at hand, and it seems to me that is what we should do here, that to the extent to which the welfare of engineers has not been taken care of by the American Society of Civil Engineers, we should change our attitude, and if necessary our Constitution, so that we can keep abreast of the times.

It seems to me that there is absolutely no occasion for us to seek out new activities, new organizations to do the things that this Society was organized to do and has done fully as well as any other organization, and which, with the prestige of its membership and the accumulation of its good work back of it, I feel it can do better than any other organization.

T. C. Hatton, M. Am. Soc. C. E.—I desire to support what Mr. Loweth has said. It seemed to me while Mr. Hunt was reading the report—I had not read it before—that the Committee proposes to give birth to a child which must be taken care of until it is strong enough to take care of itself. I have been connected with a great many associations. I am now connected with one in which the different local associations of the various National Societies and a few of the civil engineers are members. In fact, the civil engineers run the association. I think there are only about 10 or 12 members of that Society, while there are 400 or 500 members of the others. Our National Society has never done a thing for us, never suggested doing anything for us. I am also President of the State Engineers' Society. We have never had any recognition of any kind from our Parent Society, and, up to the present time, all the associations to which I have belonged—and I have been an officer of most of them—have not had any affiliation with a National Society, and I do not see that these committee reports will do us any more good. I know you have congratulated the Committee, and its members have done hard work, but right back of its report is the same old story; you can see the proof of it in this room—look at the bald heads present—we have been coming here for years. You do not see very many young men; there is not a really young man here. Why does he not come? Because we old men who have been coming here for years, do not want to be disturbed from our old ideas. It does not appeal to the young men, that attitude. Out of 54 or 55 young men in my organization, whom I have asked several times to become members of the American Society of Civil Engineers—some of them are members—many put up the question: "What is the Society going to do for me? I read your *Proceedings,* but they are far too technical for me to understand. They do not come down to bed-rock like the engineering magazines. I cannot understand them; I am not well enough educated to understand them; they do not do me any good. I get my information from the *Engineering News-Record* and other papers of that kind."

One thing in Mr. Right's remarks appealed to me. He spoke about the increase in dues. I am in hearty accord with it; to anything that is going to assist the younger men in our organization, I say "Amen".

Another thing, Mr. Blakeslee spoke about the publications: If the Publication Committee of our Society should invite the younger element of the Society to contribute to the publications, I think they

would be a great deal more interesting and bring our younger men closer to the Society than we have ever been able to bring them. If, however, you are going, with this report, to organize your local members into societies—city or district, and then State—and then let them swim or sink for themselves, it will be worse than it is now. You talk about personal service. I preach that all the time; but I want you to know that there is something besides personal service—it is Society service. We cannot be satisfied with personal service, each person must give his service to the Society too.

A. F. Blaser, M. Am. Soc. C. E.—I have an apology or two to offer for being here: First, I am not bald-headed, so I do not believe I can classify; second, I believe this is the "cold" room, and I thought we were to have a warm welcome. I should call it a hot reception, so much so that I really feel like apologizing for saying anything.

On the other hand, I feel that the Committee on Development is still here, and as we all come from various parts of the country, it seems to me that there is no better opportunity for the Committee to become acquainted with our views than now. It is for that reason only that I care to say a few words.

By what Messrs. Loweth and Hatton have said, I am reminded of a little story which will illustrate my idea: Traveling abroad, in Rome, some years ago, we ran across an American who had been all over the city, and had seen all the wonderful sights in that old civilization. Some one said to him, "How have you enjoyed them?" "Well," he said, "it is pretty fair, but do you know I have not had a good steak since I have been here in Rome?" I confess that I felt there was nothing further to discuss after that statement.

I have a great deal of sympathy for all those who feel toward the Society, as they evidently do, that it has represented and does represent a certain tradition which must be respected. I feel very strongly on that subject. We are engineers. This is an Engineering Society, and I believe in the technical definition absolutely. It is, therefore, with some hesitancy that I mention the other thing that it is necessary to mention, the fact that you must consider the welfare of the younger engineers whether you wish to or not. If this Society is going to prosper and succeed, it must be done—with all due respect to the older men. And with all their love for the Engineering Society—the American Society of Civil Engineers—I think they will have to face this other issue also. I have come rather slowly to Minneapolis, from Cleveland, stopping in several places. I called on a man who had charge of a very important piece of work, and there were a number of negroes on the job, whose pay was the same as his. He said that on a certain night he had had charge of a gang of men on important work, all that night and next day, on the time basis, and each man under him had drawn $15 pay, while he had drawn $7.

Now, I do not like to mention these things, but I do believe it indicates something which we have to recognize. I am immensely pleased that a good portion of this report is devoted to welfare work. I believe that those who read the signs of the times must recognize that the world is not quite as it used to be, whether we wish it or not, for the simple reason that there are other organizations (and I am not referring particularly to engineering organizations), but there are other organizations in the world, which are looking out primarily for the welfare of its members, and we must recognize that there is a lack which should be overcome. I have had many men speak to me about this. They say, "We do not like to do this, but what can we do?" I merely mention that subject in order to give what my experience would dictate. I wish to congratulate the Committee on emphasizing that feature of the work.

J. A. Ockerson, Past-President, Am. Soc. C. E.—I want to say that there is one thing we should try to overcome, and that is the indifference among the majority of members of this Society about voting. Ask the members to express an opinion or vote on any subject, no matter how important, and you will get about one-third of them to reply. That is something we should take into consideration when we start out on this propaganda, and that is what we ought to eliminate.

As to the young man who asks, "What can you do for me?" He should realize that he has something to do for the Society. He is apt to forget that.

Tributary to our Local Association in St. Louis, we have normally more than 200 members; that is, we have about 60 who pay a small fee for membership. If the Parent Society should conclude to allow each local association a certain sum for carrying on its business, that might help; we have tried in various ways to get local members to join our local association, but with indifferent success. Perhaps the Development Committee can find some practicable method of listing all members within a given district as members of a local association.

We had a meeting recently, and something came up from which it appeared that the Local Association would take a step that the National Society had not authorized. It was suggested that our Constitution, approved by the Parent Society, did not allow us to do that, and one member responded, "The quicker we cut loose from it, the better." That is another phase to be considered. How far can the Society properly control the actions of the local associations? I mention these few practical points which have occurred to me as these talks have been made.

A Member.—I want to say that I am heartily in favor of the plan proposed by the Committee, but the question arises, How will you perfect it? Will you leave it to a development committee scattered all over the country, and composed of men busy with other duties?

It seems to me that the time is now ripe for engineers to get together and plan something to perfect this re-organization. That means a vast amount of work, which you can hardly expect to have performed voluntarily. I suggest that the Society take the lead and that the other National Societies be asked to come in and raise sufficient funds to put this re-organization into effect, and that a sufficient amount be raised afterward to carry on the work of the organization. It seems to me we ought to take steps at once to raise at least $1 000 per annum, to carry on this work. It will be necessary that the local associations be made to aid in doing this. If it is left entirely to voluntary effort, it will take several years to accomplish. So I want to suggest now that we raise the funds and that the Society take this up at this time.

G. C. Mason, M. Am. Soc. C. E.—There is one point in connection with this report that has not been thoroughly brought out, that is, the fact that this Committee has done a great deal more work than is indicated in the report. The report has been made as brief as possible, touching only the fundamentals, and I doubt if the last speaker is familiar with the extent to which many of the details have been worked out.

As to the matter of increasing the dues, I believe I am correct in saying that such an increase is a matter of secondary consideration. A member is not asking whether our dues are $15 or $25. He is asking, Am I getting value received? If the Society gives him $25 worth, he is perfectly willing to pay that sum.

Charles Hansel, M. Am. Soc. C. E.—I believe that we as engineers take a great deal too much credit for our accomplishments. I think we talk too much about it. I do not hope to get others to agree with us, to be obsessed in the same way, until each of us takes not only an active part but an actual part in the civic work of the community. From time to time we have been asked to take an active part, which we should do, not as engineers, but to associate ourselves actively with civic bodies as citizens of the United States, forgetting all the time that one is an engineer, if he can, and going in and doing his share as a citizen.

I shall hope that all of you will agree with Item 8 on page 7 of the report, that that should be the sentiment of this Convention and should be uttered to the world. It is a duty proudly to be achieved. You have heard a great deal of what is due us, but not so much about what is due from us to other people. I have gotten into this civic work, and I find that I have been an awful slacker. I believe that any one who has gotten into it, will find that he has been a slacker; and so I have been obsessed, through all these Committee meetings, with the feeling that somehow or other we should get our Society to say to the world that we have found our obligation and are now pre-

pared to undertake to discharge that duty; and I shall hope that this Convention will send out to the world the sentiment, if not the phraseology, contained in Item 8, in the drafting of which I confess I had a hand. Change it if you will, as to the wording, but do not take out the urgent call that each engineer shall join the civic association of his community.

George G. Anderson, M. Am. Soc. C. E.—Gentlemen, Members of the American Society: Being a member of the Committee on Development, I do not feel that I should say very much at this time. I think the members of the Committee are here in a receptive attitude; we have submitted a report, to be presented at this business meeting. In the preparation of that report, we have more or less unconsciously listened to expressions of the members of the Society on the subjects before us, and we desire at all times to get as many as possible of those expressions.

There are, however, one or two points I want to refer to, to elucidate some questions which have been raised.

I think it is fitting for myself, and in that I may speak for the members of the Committee, to say that we are very grateful for the kind remarks that have been made about this report. I think we have unburdened ourselves at this time. Personally, I am not altogether satisfied with it, and I am very pleased to find that others have a better opinion of it than I myself have. I accepted appointment on this Committee in the spirit Mr. Nethercut has mentioned—that of service—as I am sure all the members of the Committee did. I had been thinking along this line for a number of years, and I was particularly impressed with one portion of the resolution creating the Committee, that the "sociological and economic conditions are in a state of flux and are leading to new alignments of the elements of society." I think that was the crux of the situation and that that was the impression conveyed to the Committee on Development. I said, at the first meeting in Chicago, that I had approached the whole question with an entirely open mind. I am still of an open mind, and I think every member of this Committee is of an open mind, although more or less committed to the principles of this report; we are of an open mind on the subject of the grave changes which must be considered by this Society, whether we like them or not, and which must be considered and acted on by the Profession at large.

Personally, I am entirely in sympathy with the view that any change we may bring about must be based on what Mr. Blaser has referred to as the recognition and understanding of the needs and the wants of the younger members of the Profession; and I think the whole report which has been submitted for your consideration, is based on that fundamental idea, first, on the individual member, and, particularly, the younger members of the Society or the Profession, and

then on the method by which he can get together with others, and that is through the local associations. It is just in expansion, perhaps, or illumination of what some of the local associations in some sections of the country have done in that respect, that I want to touch on, and particularly in their aspect to the question that Professor Swain referred to, that is, the question of license. I am in accord with Professor Swain, to some extent, when he says that he is opposed to the principle of license. I think we must recognize that the Profession is divided on that question; but whether we are divided or not, we have to meet that question as a practical question, and it is the duty of this Society and of the combined Engineering Profession to meet it intelligently, and, if I may say so, intellectually. It is not a local question. It is a matter for consideration everywhere; it has been or is before legislative bodies in New York, Indiana, Florida, Idaho, Oregon, California, and elsewhere. It is true that a joint committee in 1915 drafted a license law, and it is also true that nothing whatever was ever done with that draft. I think that is correct? Now, whether or not the question of licensing is desirable, from the point of view of the individual members of the Profession, licensing is coming; it is inevitable, and I believe, and have contended for nine years, that this Society should get ready to meet the inevitable. What is the result so far? What about the licensing laws in the various States? They all differ in some degree. I think it may be said, with fairness and justice, that the older men are handicapped by these laws; that injustice is done to the older practitioners, and, in many instances, to the younger ones, because of the complexity of the laws. There is one State which has a law that may be administered in such a way that any of you gentlemen going there, from other States, would find the doors barred against you absolutely; there is no way to get around it. What is happening elsewhere? In California, this year, acting for good and sufficient reasons, the engineers in one section introduced a bill to counteract the effects of a law threatened by other associations; the joint engineering societies of San Francisco met and considered it, and as such joint society approved the bill unanimously and put it into the Legislature with the recommendation that it be passed. The bill was sent south to be considered by the Profession of the southern part of the State, and the Southern associations unanimously disapproved of the same bill which the Northern associations had unanimously approved. The Profession was up against an *impassé*, an intolerable one in my judgment, because it seemed to me to be undesirable to appear before the Legislature with an admission that the Profession of Engineering was widely divided, in a division which was apparently unbridgeable. What was the result? In Los Angeles, there is a joint technical society consisting of seven member organizations, and I will touch later on some of the details of that organization,

to illustrate some of Mr. McDonald's remarks. Out of the consideration of the license bill in San Francisco, a joint technical society was there created, consisting of five member organizations. These two technical organizations got together in discussion of this bill and agreed on its withdrawal and the obliteration of the differences between the two sections, and the creation of a State organization has resulted for the purpose of considering legislation itself, of presenting legislation that is desirable, and of opposing legislation that is undesirable.

That is exactly the basis of the proposition for a State and National council submitted to you in this report. I am sure that all the members of the Committee on Development feel as I do, that, somehow or other, this proposal can be worked out on that basis. We do not contend that the machinery we have outlined—not in detail—is just what we want; we, therefore, invite your opinions, your criticisms, and your suggestions, and we feel that we must act together, in order to take care of what may be said to be the most important subject in the report.

As to the suggestion of Mr. McDonald: There is in Los Angeles, among this body of joint technical societies of seven, a local society, the oldest in the city, and that local association is incorporated with the seven. That society includes members—engineers—who could not otherwise be got into any National Society, but who ought to have a voice and representation and consideration in any non-technical work that is to be done by the combined societies or professions; and I think that answers very largely what is in Mr. McDonald's mind, as he has evidenced by his own experience.

Some other questions asked here very properly raised the question of the necessary dues to work out all this programme. I will not discuss that subject at length at this time, but I do endorse the general proposition that if and when the Society, either as a unit or as an aggregation of societies, will "put over the goods" and will deliver to the young men of the Profession, and to all of us, more than we are getting to-day, there will be no difficulty about getting the dues necessary to carry out the work. Of that, I am personally satisfied in my more or less constant consideration of this question with the younger members of the Profession.

In Los Angeles, at one time, there was some difficulty with the Local Association of the Society. The membership had fallen off, and we very properly concluded that it was due to the fact that a great many of the members were living at points not particularly accessible to Los Angeles as a center; it meant some effort and some sacrifice to attend the meetings. At the beginning of 1919, we instituted a system of holding monthly meetings for the presentation and discussion of technical papers, and I will say here, that I think the character of those papers is such as to be worthy of presentation to and acceptance by the Parent Society, and I have no doubt they will be so accepted. We

published bulletins containing abstracts of the papers, and we have increased our membership 25% in the last three months. I think I conclude rightly that it is an evidence of the desire of the membership, to get something, and of the members' readiness to "come through", if they do get it.

I am quite sure that I can say for all the members of the Committee on Development, that we are very grateful for your appreciation. We have worked hard, and we are glad to have you think that we are on the right track and that we are doing what we can. We have worked hard and we propose to continue to work hard, but we do want to know now how the membership feels, to guide us and help us in our deliberations and conclusions.

O. H. Dickerson, M. Am. Soc. C. E.—One of the ancient philosophers represented the gods as enjoying themselves on the top of Mount Olympus, busy with their own pursuits and utterly indifferent to the sufferings of humanity below. I have wondered sometimes if a great many of the engineers who are members of our National Societies, as well as many who are not, do not look on those national societies as those philosophers did upon the gods. It seems to me that the proper effort has not been made by our societies to get all qualified engineers into them. I think there can be no satisfactory solution of this question until every man who has qualified as an engineer is a member of an engineering organization; until the Profession is a unit; until we can express our opinion and command the attention of the people we want to hear us.

Professor Swain mentioned the code of ethics suggested by the Development Committee, and seemed to fear it would be difficult to devise a positive code of ethics which should be brief. Of the two codes of ethics that hold a prominent place in our civilization—one is largely negative and is quite long, and the other is positive and very short. So I think it is possible to work out that question.

Another thing, twenty-one years ago this month I left the engineering school, having completed my course, and entered what I fondly hoped was going to be a Profession. They never told me it was a profession at the engineering school. We did a great many things pretty thoroughly, and learned a good deal, of course, but we were never given any instruction whatever about our duties as professional men. Though students of law and medicine have developed in them a keen professional consciousness, I believe our Profession has never taken the position it should as to the engineering students in the engineering schools of this country. I believe that the engineering societies should see to it that students are taught from the beginning that they are to be professional men, until there is developed a professional conscience among all the engineers of the country. That is what we will have to work for if we want any plan of development to

be effective in advancing the standing of our Profession to the position relative to the other professions that we ought to occupy.

THE PRESIDENT.—Gentlemen, I notice that quite a number of members have left. I do not know whether it is on account of the heat, or what; but this is a very interesting subject, and I think every one ought to have an opportunity to give any information which will help the Development Committee. As no one else cares to say anything, I will ask Professor Talbot if he will say something in closing the discussion for the afternoon.

A. N. TALBOT, PAST-PRESIDENT, AM. SOC. C. E.—I do not know that I can say much on this subject at this time. When I was elected President of the Society, and looked further into its work, it seemed to me that it would be worth while to inquire into the field of its work and learn whether we were fulfilling all the duties and responsibilities which should be undertaken by such a society. Among the matters that came to my mind was one which has been mentioned several times this afternoon, our relation to the younger man, giving him service and getting him to give service. As time went on, it seemed to me that a committee should be appointed for the consideration of all such matters. The time was not propitious; in fact, many discouraged attempting anything until after the war. It seemed almost to approach disloyalty to engage in activities other than carrying on the war. At the June, 1918, meeting of the Board of Direction, however, a resolution was presented, calling for the appointment of a Committee on Development. Its value was greatly increased through the very excellent elucidation of its purpose, as expressed in a preamble drafted by a committee which I think should have credit for it—Messrs. J. W. Alvord, A. D. Flinn, and A. M. Hunt. The resolution was promptly passed by the Board of Direction. It took some time, of course, to get the work started. I have kept in touch, in a way, with the work of the Committee since that time. I attended the meeting in Chicago in November, and I know the spirit of the Committee in the work. I am much pleased with the form of the report presented here to-day. As stated by Mr. Mason, the Committee has a large amount of material which the several sub-committees have gathered and worked up; it seemed best not to present that, but to give in terse form the fundamentals of the problem as the Committee saw it, to put before the membership the matters which the Committee feels should be considered, in order that there may be discussion, and that the opinions of the membership may be learned. The very topics given in the report indicate things of importance to the Society, to its members, and to its work—the matter of Local Associations, the relations of State and National organizations doing the especial kinds of work, something for the younger men of the Profession, personal service, technical activities, publicity, services of the engineer to the community, State and nation.

I trust that the discussion this afternoon will not be the end of such discussion. I am very hopeful that when this report is sent out to the membership of the Society, and especially when it is discussed at the meetings of the Local Associations of members all over the country, there will be a very full and thorough discussion and that the members will send in their views to the Committee so that the Committee may have the benefit of them in preparing a further report.

I wish to call attention at this time to the statement made by Maj. Williams concerning the Committee's methods of work, that it is its plan eventually to send out to the membership a series of questions, in order to get the views and vote of the Society on these various matters; because it would be of little use to make a report and then have a committee prepare amendments to the Constitution, or a new Constitution, when a vote would show that the membership of the Society does not believe in doing that thing at that time. We must, it seems to me, know the sentiments of the Society, and then prepare a document to carry out its wishes; and it is to be hoped that a plan made after a vote is taken will be adopted and carried out. I am very hopeful that the work of the Committee will result in great advantage to the Society and to its membership.

THE PRESIDENT.—It is not my desire to cut off the discussion in connection with this matter, but I do not understand that any one else cares to discuss the Committee's report. The Secretary has something to say, and we will listen to him now.

THE SECRETARY.—Mr. President, I have the following letter from the Secretary of the Engineering Institute of Canada, which I will read:

"MONTREAL, May 23d, 1919.

"DR. CHAS. WARREN HUNT,

"Secretary, American Society of Civil Engineers,

"33 West Thirty-ninth Street,

"New York City, N. Y.

"DEAR DOCTOR HUNT:—It was a pleasure to receive your letter of May 20th kindly extending an invitation to be present at your coming summer meeting at St. Paul, together with one of the officers of the Institute.

"Brig.-Gen. Sir Alex. Bertram, member of Council, has kindly consented to visit the western branches with me during the summer, and on consultation with him regarding visiting St. Paul at a time to include part of your summer meeting, he stated that it would give him much pleasure to do so and I wish to express the same sentiments.

"We have accordingly arranged our schedule to arrive in St. Paul on the evening of June 16th, with the expectation of being with you for at least two days of your meeting, namely, the 17th and 18th. I am forwarding copy of your letter to President Lieut. Col. R. W. Leonard, who resides at St. Catharines, in the hope that he might also find it possible to be present.

"Sir Alexander was Chairman of the Shell Committee in Canada which initiated the manufacture of munitions in this country and did such excellent work in that connection.

"Looking forward with pleasure to seeing you at your summer meeting and thanking you for your courteous invitation to be present, I remain

"Yours sincerely,

"FRASER S. KEITH,
"Secretary."

In connection with this matter, I have just received the following telegram:

"CHICAGO, ILLS., 3:10 P. M., June 17, 1919.
"CHARLES WARREN HUNT,
"Radisson Hotel, Mpls., Minn.

"General Bertram cannot attend convention, arriving Wednesday morning.

"FRASER S. KEITH."

THE PRESIDENT.—There seems to be nothing else, and a motion to adjourn is in order.

(Motion duly made, seconded, and carried.)

Adjourned.

FORTY-NINTH ANNUAL CONVENTION

EXCURSIONS AND ENTERTAINMENTS

The arrangements for the Convention were in the hands of the following Committees:

Committee of Arrangements of the Board of Direction

W. L. Darling, *Chairman,*

E. E. Wall — Chas. Warren Hunt

Local Committee

R. D. Thomas, *Chairman,*

W. C. Armstrong	W. N. Jones
F. H. Bass	F. C. Shenehon
R. B. C. Bement	Horace E. Stevens
F. W. Cappelen	Howard E. Stevens
Oscar Claussen	P. E. Thian
William de la Barre	W. T. Walker
F. E. House	George L. Wilson
W. H. Hoyt	L. P. Wolff

Ladies' Theatre Party

Tuesday, June 17th, 1919.—1.15 P. M.—The visiting ladies were the guests of the Ladies' General Committee at a theatre party in St. Paul. The party was greatly enjoyed and was attended by about 40 ladies.

Reception

Tuesday, June 17th.—9 P. M.—A reception tendered by the Local Membership, and attended by about 175 members and guests, was held in the Gold Room of the Radisson Hotel. Dancing was enjoyed.

Automobile Drive Around the "Twin Cities"

Wednesday, June 18th.—The day was devoted to an automobile drive of 33 miles around the "Twin Cities", the itinerary of which had been admirably planned by the Local Committee so that all points of interest were shown to the visitors. The automobiles, furnished through the courtesy of the Local Membership, left the Radisson Hotel at 10 A. M., touring Minneapolis, and arriving at the St. Paul Hotel, St. Paul, for luncheon at 12.30 P. M. The trip was continued about St. Paul, ending at the St. Paul Town and Country Club, where the party was entertained at a dinner dance by the St. Paul Engineers' Society. The affair was a most enjoyable one and was attended by about 200 members and guests. Before reaching the St. Paul Town and Country Club, a stop was made, by invitation, at "Stone Bridge", the residence of Mr. Oliver Crosby, where the party was most hospitably entertained by Mr. and Mrs. Crosby.

Excursion to Lake Minnetonka

Thursday, June 19th.—The day was devoted to an excursion by trolley to Lake Minnetonka, about fifteen miles distant from Minneapolis, and included a delightful two-hour sail on the lake, the party reaching the Lafayette Club in time for luncheon, after which there was dancing. In the afternoon, a Golf Tournament was held on the links of the Lafayette Club, for which prizes were offered by the Local Committee. The party, consisting of about 118 persons, returned to Minneapolis, *via* the Great Northern Railway, in time for dinner.

Smoker

Thursday, June 19th.—8.30 P. M.—A lecture, illustrated by lantern slides and motion pictures, was given in the Gold Room of the Radisson Hotel, by Lieut.-Col. F. W. Scheidenhelm, M. Am. Soc. C. E., Corps of Engineers, U. S. A., on "The Work of Army Troops of the American First Army in France." After the lecture, an informal farewell "Smoker" was tendered the members and their guests by the Minneapolis Engineers' Club, on the roof garden of the hotel, to which the ladies of the party were also invited. There was dancing and light refreshments were served. The evening was a great success, the attendance being about 150.

Excursions to Manufacturing Plants, etc.

Friday, June 20th.—The morning, which had been left free, was spent by the members and guests in visits to manufacturing and industrial plants, flour mills, etc., and other points of engineering interest, under the charge of the Local Committee.

Excursion to Duluth, Minn., and the Missabe Iron Range

Friday, June 20th.—About 125 members and guests, left Minneapolis by special train at 1.30 P. M., *via* the Northern Pacific Railroad, and arrived at Duluth at 7 P. M., dinner having been served on the train. The evening was spent on a trip by steamer around the Duluth-Superior Harbor, as guests of the Duluth Association of Members of the American Society of Civil Engineers and the Duluth Engineers' Club, and was greatly enjoyed. There was dancing on the boat.

Saturday, June 21st.—After a night run from Duluth, over the Duluth, Missabe, and Northern Railway, the special train arrived at Hibbing at 9 A. M., where the party, as guests of the Engineers' Club of Northern Minnesota, was taken, on flat cars, through the Hull-Rust-Mahoning Open-Pit Mines. After luncheon at the Oliver Club, the visitors motored 30 miles along the Iron Range to Eveleth, obtaining a splendid view of the Missabe open-pit mines and their development, including the operation of the largest steam shovels in the world.

At Eveleth the special train was again taken over the Duluth and Iron Range Railroad to the ore-shipping port of Two Harbors, where the visitors were given an opportunity to inspect the ore docks from which the shipments of ore from the Missabe Range are made. At 8 P. M., the party left Two Harbors for the return trip to Duluth, which was reached at 9 P. M. After a stop of three hours at Duluth, during which the party was pleasantly entertained by the Duluth Association of Members by an automobile trip around Duluth and by a dance at the Kitchi Gammi Club, the return was made by the special train, which arrived at St. Paul and Minneapolis early on the morning of Sunday, June 22d, thus allowing the visitors ample time to catch morning trains east or west. This trip was most enjoyable, and the party was delightfully entertained by the Local Membership at every point visited.

Attendance

The following 149 Members were in attendance. There were also present 135 ladies and guests of the members.

Allee, O. P.....Kansas City, Mo.
Allen, R. L.....Syracuse, N. Y.
Alvord, J. W.....Chicago, Ill.
Anderson, G. G..Los Angeles, Cal.
Annan, C. L.....St. Paul, Minn.
Armstrong, W. C..St. Paul, Minn.
Bass, Frederic.Minneapolis, Minn.
Bates, Onward.....Chicago, Ill.
Bensel, J. A.....New York City
Blakeslee, Clarence, New Haven, Conn.
Blaser, A. F.....Cleveland, Ohio
Bowen, O. S.....Seattle, Wash.
Boynton, G. H...Muscatine, Iowa
Brace, J. H.....New York City
Briggs, E. G.....St. Paul, Minn.
Brillhart, J. H.....Dallas, Tex.
Bruntlett, E. H..Blue Island, Ill.
Buehler, Walter.....Chicago, Ill.
Cappelen, F. W., Minneapolis, Minn.
Carey, W. N.....St. Paul, Minn.
Chandler, E. F., University, N. Dak.
Childs, J. A.....St. Paul, Minn.
Claar, R. S....Minneapolis, Minn.
Clark, W. A.....Duluth, Minn.
Claussen, Oscar...St. Paul, Minn.
Clements, M. F....St. Paul, Minn.
Connor, E. H..Leavenworth, Kans.
Conway, J. S...Washington, D. C.
Cowin, James..Minneapolis, Minn.
Cowles, W. P..Minneapolis, Minn.
Crocker, H. S....Brooklyn, N. Y.
Cummings, R. A..Pittsburgh, Pa.
Currie, C. H...Webster City, Iowa
Curtis, F. S.....Boston, Mass.
Cutler, A. S...Minneapolis, Minn.
Daniels, Arthur, Minneapolis, Minn.
Darling, J. H.....Duluth, Minn.
Darling, W. L....St. Paul, Minn.
de la Barre, William, Minneapolis, Minn.
Dickerson, O. H...Duluth, Minn.
Doten, L. S...Washington, D. C.
Elmer, H. N.....Chicago, Ill.
Elwell, C. C...New Haven, Conn.
Farnham, Robert, Philadelphia, Pa.
Felton, H. C.....Camden, N. J.

Flinn, A. D.....New York City
Frick, O. H.....Milwaukee, Wis.

Gates, C. L.....Toledo, Ohio
Gauger, P. C.....St. Paul, Minn.
Gillette, L. S..Minneapolis, Minn.
Gilman, J. B..Minneapolis, Minn.
Goodwin, W. R.,
Minneapolis, Minn.
Green, H. R..Cedar Rapids, Iowa
Grunsky, C. E., San Francisco, Cal.

Haberle, E. L..Minneapolis, Minn.
Hadwen, T. L. D....Chicago, Ill.
Haehl, H. L..San Francisco, Cal.
Hall, J. L.....Seattle, Wash.
Hallsted, J. C.....Chicago, Ill.
Hamlin, Ralph. Minneapolis, Minn.
Hansel, Charles..New York City
Hatton, T. C....Milwaukee, Wis.
Haupt, Edward.....Chicago, Ill.
Hawgood, Harry, Los Angeles, Cal.
Herrold, G. H....St. Paul, Minn.
Hogeland, A. H..St. Paul, Minn.
Honens, F. W.....Sterling, Ill.
Houston, W. O....Jackson, Mich.
Howson, E. T.....Chicago, Ill.
Humphrey, R. L..Philadelphia, Pa.
Hunt, Chas. Warren,
New York City
Hustad, A. P..Minneapolis, Minn.
Hutchinson, G. H..St. Paul, Minn.

Jensen, J. A..Minneapolis, Minn.
Jones, H. W..Minneapolis, Minn.
Jones, W. N..Minneapolis, Minn.

Ketchum, M. S....Boulder, Colo.

Loida, J. L.....St. Louis, Mo.
Lovering, H. D....St. Paul, Minn.
Loweth, C. F.....Chicago, Ill.

McDonald, Hunter,
Nashville, Tenn.
McDonald, W. F., Milwaukee, Wis.
McGrew, A. B.....Pittsburgh, Pa.
Mason, G. C.....Portland, Ore.
Mehren, E. J.....New York City
Metcalf, Leonard...Boston, Mass.
Meyer, A. F..Minneapolis, Minn.
Molitor, F. A.....New York City
Morse, C. A.....Chicago, Ill.

Nethercut, E. S.....Chicago, Ill.
Newton, R. E....Milwaukee, Wis.

Oakes, L. S...Minneapolis, Minn.
Ockerson, J. A.....St. Louis, Mo.

Patton, W. B.....Duluth, Minn.
Pegram, G. H....New York City
Pillsbury, C. L. Minneapolis, Minn.
Powrie, W. R.....St. Paul, Minn.
Prince, G. T.....Omaha, Nebr.
Pruett, G. C....Miles City, Mont.

Ralston, J. C.....Spokane, Wash.
Riggs, M. J.....Toledo, Ohio
Rights, L. D.....New York City
Rogers, E. H..West Newton, Mass.

Scales, G. C..Minneapolis, Minn.
Scheidenhelm, F. W.,
New York City
Senior, F. S.....New York City
Shenehon, F. C.,
Minneapolis, Minn.
Sloan, S. A.....Philadelphia, Pa.
Smith, C. U.....Chicago, Ill.
Smith, R. L.....St. Paul, Minn.
Sprague, N. S....Pittsburgh, Pa.
Stearns, F. P.....Boston, Mass.
Stevens, Horace E..St. Paul, Minn.
Stevens, Howard E.,
St. Paul, Minn.
Strickler, G. B..Washington, D. C.
Stuart F. L.....New York City
Stuart, J. T.....Philadelphia, Pa.
Swain, G. F.....Boston, Mass.

Talbot, A. N.....Urbana, Ill.
Talbot, K. H.....Milwaukee, Wis.
Tatum, R. L.....La Grange, Ill.
Taylor, C. F.....New York City
Thian, P. E.....St. Paul, Minn.
Thomas, R. D..Minneapolis, Minn.
Tinkham, S. E.....Boston, Mass.
Trout, C. E.....New York City
Turner, C. A. P.,
Minneapolis, Minn.
Tuttle, A. S.....New York City

Vogdes, J. J....Philadelphia, Pa.

Wachter, C. L., Minneapolis, Minn.
Wagner, S. T...Philadelphia, Pa.
Walker, J. W...Philadelphia, Pa.
Walker, W. T.Minneapolis, Minn.
Warren, G. E.....Chicago, Ill.
Washburn, D. C..Elk River, Minn.
Weymouth, F. E....Denver, Colo.
Wheeler, W. H.,
Minneapolis, Minn.
Wilbanks, J. R...Columbus, Ohio
Willard, E. V....St. Paul, Minn.
Williams, F. P.....Albany, N. Y.
Williams, G. M., Washington, D. C.
Williams, G. S..Ann Arbor, Mich.
Wilson, G. L..Minneapolis, Minn.
Wolff, L. P.....St. Paul, Minn.
Woodbury, W. H..Duluth, Minn.
Woodward, S. M..Iowa City, Iowa

Yates, J. J.....New York City
Young, R. C....Marquette, Mich.

ENGINEERING ACTIVITIES OF THE TWIN CITIES

Address by F. C. Shenehon, M. Am. Soc. C. E., at the Forty-Ninth Annual Convention of the American Society of Civil Engineers, June 17th, 1919.

It has become customary to include, as a part of the programme of the Annual Convention, an address by a member of the Society resident in the region where the Convention assembles. On the part of the Administration and the visiting members the conferring of this privilege of address is a fine courtesy bestowed on the locality, and the particular local member chosen to voice the home sentiments must not be outdone by the Administration. Let me assure you at once, therefore, that I shall do you the supreme courtesy of being brief. The rarity of a June day must not be imperiled by a lengthy discourse.

The home address would be delivered more appropriately by our distinguished fellow member, Mr. William de la Barre, Chief Engineer of the St. Anthony Falls Water Power Company, who could speak with the high authority of his long service here and his more intimate knowledge of local engineering and industrial evolution. He has watched the development of engineering projects here with the same paternal and understanding interest which a father bestows on the unfolding of the potentialities of his children. Doubt as to his ability to take part in the business of this Convention, arising through illness in his household, compelled Mr. de la Barre to deny himself the privilege of formally addressing you.

My subject, as set down in the programme, is "Engineering Activities of the Twin Cities". In interpreting this subject, it will be assumed that the Twin Cities are simply the hub of a radiating series of engineering activities that follow transportation lines southward to the Gulf of Mexico, reach northward to the Lake of the Woods, and, loosely defined, eastward and westward to the Gulf of St. Lawrence and the Red River of the North. You will observe that the engineering activities of the Twin Cities are far-flung!

As I proceed to develop my theme, Sherlock Holmes might discover that my interests and convictions are hydraulic, because Water, whether I will it or not, recurs and resounds like the burden of an opera.

The early voyageurs, Radisson and Groseilliers, who penetrated the wilderness and reached the prairies of Minnesota, and the Mississippi River in the vicinity of Winona, some miles south of St. Paul, started their pioneering journey at Montreal, proceeded by canoe up the Ottawa River to Georgian Bay, Lake Huron, thence to the inlets along the west shore of Lake Michigan, and, finally, made an overland journey of 150 miles westward to the Mississippi. This was about the middle of the 17th Century. These voyageurs prepared no maps of this

region. Joliet, in 1673, reached the Mississippi by way of Lake Michigan and the Illinois River, and opened a water avenue from the south for French exploration of Minnesota. Almost exactly 240 years ago, at this time of year, Sieur Duluth landed in the vicinity of the present City of Duluth, and penetrated the inland country of Minnesota to Mille Lacs about 70 miles from Minneapolis—the first white man to report and record his explorations. Later, Father Louis Hennepin (in the summer of 1680) came to St. Paul, and went on to the cataract, to which he gave the name of his patron saint, Anthony of Padua. The Dakota Indian name for St. Anthony Falls was "Minni-i-ha-ha"—the rushing water—a name now transferred to the smaller Falls immortalized by Longfellow, "Minnehaha"—laughing water.

These pioneers were Exploration Engineers, and their activities have had to do with present engineering activities in the Twin Cities —and they reached here by water transportation in birch-bark canoes. The motives of these exploration engineers, engaged in a reconnaissance survey for the advance of civilization across a continent, were mixed. The inculcation of religion in pagan souls, the extension of imperial domains, fur trading, adventure, and the search for a westerly passage from France to China—all had a part. The naming of the St. Lawrence Rapids at Montreal, Lachine Rapids—or the Chinese Rapids—illustrates the geographical misapprehension as to the nearness of the Orient, which was actually more than 8 000 miles toward the sunset. It is said of Nicollet: "So confident was he of reaching China that he took with him a gorgeous mandarin's robe of damask to wear at his court reception."

This Minnesota country, penetrated by these exploration engineers, was inhabited by savage peoples—Indians—whose chief engineering activities were military—eternal warfare. They subsisted by hunting and fishing perhaps more substantially than by agriculture. Wild rice grew in marginal shallows of the lakes and rivers, wild fowl fed on the wild rice; moose came to the water, as cattle do, to drink, keep cool, and avoid fly pests; fish abounded; the streams were avenues of transportation—hence, aboriginal populations kept close to the waterways.

It is rather astonishing how this dependence on lakes and streams is reflected in Indian names which now exist as geographical permanencies. Minnesota means blue or misty water. The name was first applied to the Minnesota River and then taken over by the State. Missouri is Dakota for turbid water. Mississippi is Algonquin for far-reaching waters. Minnetonka means great water. Minneapolis is a half-breed name; Indian mother, "Minne", waters, Greek father, "polis", city—hence, the City of Waters. These recurring Indian names, and the French names, Radisson, Hennepin, Nicollet, La Salle, Joliet, Frontenac, and Duluth, still keep vivid the color of two cen-

turies in which the picturesque glories of French civilization met, by forest and prairie, the ancient, unprogressive, but picturesque, savagery.

My conception of a Civil Engineer is that he is a surgeon operating on the earth as his patient; and, in developing my subject, it appears desirable to touch very lightly, and very briefly, on an activity, essentially engineering, which preceded the Indian and the French in this region. The Panama Canal in some form might have been cut ages ago by geologic action, without the guiding hand of the engineer as we know him; and this surgical operation successfully completed at Panama has done a thing which we find in other places already done for us by sure, slow, constructive, geologic forces directed by the Engineer of the Universe. The problems which engineers deal with to-day, are inextricably and fundamentally dependent on natural evolutions and physical changes of the past. We take up the task at the point to which Nature has already brought it, and accelerate, retard, or modify the project. We are in partnership with every elemental, physical force of the universe, and each one of us likes to think of himself as the dominant senior partner.

Geological agencies conferred on Minnesota vast stores of hematite —the blood-red iron ore. Perhaps an account of the genesis of this deposit—the succession of events resulting in making it accessible and commercially worth while—will be of interest, particularly to those who are to visit the Iron Range. About 4½% of the crust of the earth is iron; and every stream entering the ocean carries to this omnibus catchment basin a small contribution of this metal. It gradually precipitates in the deep sea bottom, securing oxygen and carbon in part from animal and vegetable organisms, until after countless æons great beds of ore are laid down. Then, as the earth cools, State-wide slabs of crust are reared above the sea level. A glacier scrapes off and truncates this pyramidal mass. Now, this hematite, as it came out of the sea was not commercial ore, it was only about 30% iron; but, exposed to the elements, it weathers. The oxygen and carbon in part disappear, while all the iron remains, until enrichment is complete, and the ore is commercially good, with 50% or more of iron.

The geological formations exposed in the Mississippi River Gorge are interesting in their genesis, and tremendously important to the Twin Cities as bearing on present engineering activities. Down underneath is the St. Peter sandstone several hundred feet in thickness. This is made up of fine, rounded grains of white sand imperfectly cemented with porcelain clay. This sandstone is so soft that you can carve your initials in it with your finger-nail. It is porous and contains in part the artesian reservoir of water. On top of the sandstone are 4 ft. of blue shale, and, above this, about 30 ft. of limestone; then, on top, glacial drift—about 30 to 40 ft. of a mixture of sand, gravel, boulders, and clay. The sand was deposited ages ago in the sea, near shore in shallow water; then the bottom of the sea subsided, and in the

deeper water the finer sediment, mud with some lime and some organic life, formed shale; the bottom of the sea was then further depressed, and, in the deep sea, far from off-shore sedimentary deposits, the pure hard limestone formed, imprisoning in its solidifying grip the organic dead. Then the ice sheet, a mile thick over this region, melted, and left the rock débris which we call glacial drift.

The significance of these geological formations is shown by the recession of the Falls of St. Anthony from somewhere down in Iowa to its present location in Minneapolis. The destructive force of the falling water successively cut out the soft sandstone, undermining the limestone ledge, toppling it down, and permitting the persistent northward travel of the Falls, with the ever-lengthening gorge. If civilization and engineers had been in Minnesota some thousands of years ago, the water power might have been caught and held at St. Paul, and there would have then been no Minneapolis! Minneapolis itself nearly lost the water power by northward recession of the Falls some forty odd years ago; but engineers terminated the freedom of geologic action, built a great cut-off wall of concrete to protect the sandstone, and directed the flood-waters over a timber apron. The engineering activities of that day, in thus arresting the recession of St. Anthony Falls, makes an interesting chapter in local history. The Mississippi River, for 60 miles above Minneapolis, has its channel in glacial drift. The High Dam in the gorge below is founded on glacial drift mixed with fragments of limestone, while the power-house and the vessel lock, at the two ends of the dam, are founded on sandstone. The Third Avenue Bridge, a recent monumental engineering construction, is founded on the limestone ledge. The sandstone formation is readily tunneled, and Minneapolis and St. Paul, in particular, utilize it very fully for sewers.

With this historic and prehistoric background, the story of more recent developments and present engineering activities should be more understandable.

In the days when Minnesota was on the lonely frontier, St. Paul grew to be its most populous city and, later, its capital, because it was at the head of practicable steamboat navigation—a water reason. Contrary to the rule of growth of cities, which fixes them a day's journey apart, Minneapolis grew into our largest city, centering about the great water power here—a descent of about 48 ft. in a cataract in the Mississippi River, with more than 20 000 available horse-power—another water reason. Another city, Stillwater, grew up at the virtual head of steamboat navigation on the St. Croix River, a tributary stream of the Mississippi which is the trunk line of navigation leading to the Gulf of Mexico.

In passing, it may be of interest to note that, in the division of spoils in State institutions, St. Paul received the desirable Capitol,

Stillwater the desirable Penitentiary, and Minneapolis the then doubtful University, all now centers of engineering activities.

Minneapolis and Stillwater had a kinship in the fact that a form of navigation, much exceeding that of the steamboat in importance, existed in the floating of logs on the Upper Mississippi and the Upper St. Croix, which, with their many tributarities, found their head-waters in the heart of limitless forests of pine, hemlock, and cedar. At Minneapolis the forest products met water power which, with steam power, converted the logs into lumber. At Stillwater, steam sawmills were operated, and the logs were also rafted to continue their journey southward. The floating of logs was the most considerable navigation which the Mississippi River through the State of Minnesota has ever known. It is a familiar fact that a stream which floats logs and crosses a State boundary, ceases to exist only as a child of the State in which it has its source, but becomes a ward of the Federal Government subject to all the limitations and advantages which this implies. The transportation of logs and the cutting up of logs in the past have been essential and important engineering activities which now have practically vanished with the near destruction of the forests.

The water powers at Minneapolis and in the vicinity are the present dominant natural elements which create engineering activities which, in turn, supply other engineering activities. For the future, when population is dense enough, river navigation promises to mean much for Minneapolis, St. Paul, Stillwater, and other river cities.

At the present time, by the building of the High Dam and Lock, between Minneapolis and St. Paul, the actual head of navigation for steamboat service on the Mississippi River is brought to Minneapolis. The construction of this vessel lock and dam is one of the fairly recent engineering activities of the Twin Cities. The evolution of the project from a two-lock scheme which neglected the water power (10 000 h.p.) inevitably present, marks the transition of the Federal Government from the rôle of navigational proprietor alone, blind to other uses, to the larger rôle of master of both navigation and water power. It is a little discouraging, however, to note that for three years, during the war period, when our railways were congested getting coal to this water-power city, much steam-generated power was in use and coal consumed, while potential power equivalent to perhaps from 50 000 to 100 000 tons of coal per year was wasted through the sluiceways or over the crest of the dam. The dam itself is of the Ambursen type, with normal 30-ft. head, with power-house foundations built contemplating a use of 6 000 cu. ft. per sec. in generous river stages. The use of this power awaits action by Congress on a general water power bill.

The main 48-ft. drop at St. Anthony Falls is used largely for grinding flour, the most important engineering activity of Minne-

apolis. The flour mills have a story of their own, and this will be told at the mills to visitors. The annual production of high-grade flour ranges from 16 000 000 to 20 000 000 bbls.

Half a mile down stream from St. Anthony Falls, a second development exists with a fall of 18 ft.—this is used by the local traction company.

As the flow of the Mississippi River sometimes dwindles to 1 000 cu. ft. per sec. in midwinter attenuation, great steam power auxiliaries are everywhere supplied. The Riverside Station of the Minneapolis General Electric Company, with its recently installed 25 000-kw. turbo-generator, is the most colossal auxiliary of the Twin Cities, supplying current to the mills and other manufactories, and to public utilities as well, in times of low river flow.

The water-power plants and water-power sites of the Northern States Power Company on the Mississippi and St. Croix Rivers represent engineering activities, existing and of the near future, of great interest. The Main Street Station develops a portion of the St. Anthony Falls power. The Coon Rapids Dam, with an 18-ft. head, completed in 1914, is on the Mississippi River about 11 miles above Minneapolis. The Taylor's Falls plant of this Company, on the St. Croix River, about 41 miles by transmission line from Minneapolis, has a fall of 60 ft., and 20 000 installed horse-power, mostly used in the Twin Cities for manufacturing and public utilities. The undeveloped dam sites of this Company on the St. Croix and Mississippi Rivers represent, in their future development, problems of exceeding interest. Some of these dams will be on rock foundations, and some of them will mean 30 or 40-ft. heads on glacial drift foundations, which will call for most skillful planning and execution, and, doubtless, when constructed, will mean long strides of advance in the art of dam building on porous foundations.

No summary of the engineering activities pivotal on the Twin Cities can omit mention of the great head-water reservoirs of the Mississippi River. These reservoirs have utilized two large and several smaller natural lakes. Their combined capacity is more than 100 000 000 000 cu. ft., with a water-shed area of about 4 000 sq. miles, and an additional water area of more than 400 sq. miles.

Controlled by the Federal proprietor, who, by law, must regard navigation, however little it is, as the predominant interest to be served, the release of water is not always beneficial to the water powers, and sometimes is detrimental, as in midwinter when power needs are great and river flow is meager. The water powers are really at the present time a greater public resource here than navigation itself. The benefit in vessel draft is about 1 ft. at St. Paul, tapering off to zero perhaps a 100 miles down stream. I imagine it will require an act of Congress to modify the release of reservoir storage so as to give the

maximum benefit to the important water powers of the Mississippi. The attitude of the Federal proprietor is likely to change when the Federal water power at the High Dam becomes a beneficiary.

The things discussed thus far represent engineering activities which are inherent in the physical and geographical characteristics of the Minnesota region. The existence of these things has caused great aggregations of people to cluster here. This population must be served by many engineering activities. Railways must bring to them many things to supplement the regional products, and must take away the things produced here. Minneapolis and St. Paul are two beads threaded on five transcontinental lines; and four axial north-and-south lines reach toward the Canadian storehouse and the Cotton Belt. Locally, we are excellently served by a traction system which is suffering from 5-cent fares and franchise uncertainties.

The water supply here cannot fail to represent an engineering activity of transcendent interest—more particularly after July 1st. The Mississippi River which has served so efficiently in the past in bringing forest products to Minneapolis, brings also the sewage of the City of Anoka, 20 miles up stream. Minneapolis uses the Mississippi River, as it departs southward, to convey its sewage to St. Paul. These two facts made Mississippi River water a bad beverage for Minneapolis and an impossible source of water supply for St. Paul. Up to 1912, Minneapolis did pump its domestic supply unpurified from the river, notwithstanding the malign contributions from Anoka. Well-to-do people bought spring water, crystalline clear, in bottles. Venders sold water as they now sell milk—only seven years ago. The poor and the careless had winter cholera and typhoid fever. The first civic awakening dosed the water with chlorine, which helped while the present mechanical filtration plant was planned and constructed. Investigations for a better water supply gave consideration to four possible sources: Lake Superior, 140 miles away, was alluring. Mille Lacs—a lake 207 sq. miles in area—70 miles away, was enticing. The subterranean artesian supply, rising by gravity to perhaps 100 ft. below the street level here, had many advocates. The Mississippi—"a poor thing but our own"—could not be overlooked.

The investigations resulted in the rejection of the Lake Superior source as too distant, the Mille Lacs supply as inadequate, the artesian as too hard and too uncertain, and the acceptance of the sometimes turbid, sometimes defiled, but always adequate, Mississippi River water, which by skillful engineering processes has been relieved of its baser ingredients and converted into a crystalline, wholesome supply. The typhoid rate in Minneapolis is singularly low. Schools and hospitals freely use the domestic supply for drinking purposes, and all persons may meet confidently the era of alcoholically dry days. St. Paul

secures its water supply from a group of lakes, reinforced by the artesian flow.

In concluding this meandering talk on the things conceived as of vital engineering interest to the Twin Cities and their zones of influence, I wish to speak for a few minutes of the most important inland navigational resource of the world, which now brings steel vessels built on the Clyde in Scotland to our Minnesota harbor at Duluth. As the Mississippi River gives Minnesota a water route to the Gulf of Mexico, the Panama Canal, the Pacific Ocean, and the Orient, so the Great Lakes lead to the Gulf of St. Lawrence, the blue Atlantic, England, France, the Mediterranean, the Suez Canal, and the Indies. Minneapolis is at the utmost inland reach of the Mississippi, and Duluth at the utmost inland reach of the Great Lakes.

Nowhere exist such alluring, splendidly big engineering things, solved and unsolved, as in this chain of magnificent lakes and stately rivers. It has been my privilege to have had a part in the things solved, and it is still my privilege to work on the things unsolved, and I regard myself as peculiarly blessed in working within such far-reaching horizons.

The hematite ore of Minnesota is vitalized and made marketable—80% of the whole country's supply—by this waterway which carries the ore to the coal and brings coal to some of the ore smelted at Duluth. It is probable that the bulk of this ore would lie unmined and unused were it dependent on rail transportation. It costs, roundly, $1 a ton to get the ore by rail 100 miles from the Missabe Range to the lake shore at Duluth, and it costs $1 to carry this ton of ore 1 000 miles by water to Buffalo. The tonnage passing the big ship locks in St. Mary's River, at the foot of Lake Superior, exceeds the combined tonnage of the Panama and the Suez Canals.

Exit from the Lakes to the sea is still limited by the shallow drafts of the Erie, Welland, and St. Lawrence Canals; but the Welland Canal is building now for 25-ft. draft in the canal prism and 30-ft. draft in the locks; and the St. Lawrence waterway will follow this lead. That is one of the big engineering things. The New York State Barge Canal shrinks to a trifling thing, with these great projects evolving.

The Chicago Drainage Canal, diverting a considerable stream of Lake Michigan water, has created the need of the regulation of Lakes Michigan, Huron, Erie, and Ontario, by controlling works in the outflow rivers—Niagara and St. Lawrence in particular. St. Mary's River, the outlet of Lake Superior, is already under artificial control—in the interests of navigation and water power—and projects are maturing for the manipulation of the outflow of the Niagara and St. Lawrence Rivers. Each year to a greater extent it is realized that, after all, the Lakes are storage reservoirs of almost limitless capacity and incalculable value. Nature has one sole motive in her operation of the outflow

rivers, which is to rush the waters to the sea. The water returns through the heavens, and the endless cycle of rainfall and outflow goes on. This water, however, when engineers intervene, must be made to serve better the artificial uses of navigation and power. So it will come to the point where we must budget the water eventually—why not now? Budgeting the water means spending it systematically and scientifically, in well-thought-out apportionments, which will make the Niagara and the St. Lawrence better navigable ways and better water-power streams.

Water power is really the thing which inflames the imagination. Aladdin with his lamp never conjured to serve him genii so omnipotent as engineers have made emerge from seaward bound waters; and the Niagara and the St. Lawrence descending to the ocean hold in their depths potentialities to assume tremendous burdens of labor, which still pitilessly strain human muscles.

These things of which I have spoken I conceive to be, in the largest sense, the significant Engineering Activities of the Twin Cities.

REPORT OF THE COMMITTEE ON DEVELOPMENT

PRESENTED TO THE BOARD OF DIRECTION, JUNE 17TH, 1919.

LETTER OF TRANSMITTAL.

TO THE MEMBERS OF THE
AMERICAN SOCIETY OF CIVIL ENGINEERS:

At a meeting of the Board of Direction held in Minneapolis, June 16th, 1919, the Chairman presented the second Progress Report of the Committee on Development. The Board received the Report, ordered it presented to the Business Meeting of the Convention for discussion and forwarded as soon as possible to the entire membership of the Society and to each Local Association of Members, with the request that the benefit of individual or collective opinion on any or all of the fundamental points covered by this Report be communicated to the Chairman or Secretary of the Committee.

The Committee was, by resolution of the Board, authorized to hold an additional meeting in order to prepare a further report, to be in the hands of the Secretary of the Society by November 1st, so that it may be issued to the membership sufficiently in advance of the Annual Meeting to insure a thorough discussion of it at that meeting.

The Chairman of the Committee on Development requested that he be granted permission to add some material as an appendix to be printed and forwarded to the Membership with the Report, and his request was granted.

In accordance with the above action the Report was presented to the Business Meeting of the Society held at Minneapolis, June 17th, and the resulting discussion will be published in full in the August number of *Proceedings*.

In further compliance with this action of the Board there is herewith presented to each member of the Society the second Progress Report of the Committee on Development, to which is added, as an appendix, a letter from Mr. Onward Bates, Chairman, and other material forwarded by him, with the request that it be published with the Report.

Members are urged to communicate their views promptly to Mr. Onward Bates, Chairman, 332 South Michigan Ave., Chicago, or to Mr. E. T. Howson, Secretary, Transportation Bldg., Chicago.

Respectfully,

CHAS. WARREN HUNT,
Secretary.

NEW YORK, JUNE 27TH, 1919.

To the Board of Direction,
American Society of Civil Engineers:

Gentlemen:—The second meeting of the Committee on Development was held in Minneapolis, Minn., on June 11th to 16th, inclusive, and was attended by the following members:

Onward Bates, *Chairman*

George G. Anderson	George C. Mason
Baxter L. Brown	Edgar S. Nethercut
Paul G. Brown	Frederick C. Noble
J. H. Brillhart	Arthur Pew
Robert A. Cummings	George R. Putnam
W. L. Darling	J. C. Ralston
H. L. Haehl	H. R. Safford
John L. Hall	Charles J. Tilden
Charles Hansel	S. Everett Tinkham
Richard L. Humphrey	Gardner S. Williams

There were also present Mr. C. E. Lord and Professor Kimball, members of the Committee on Aims and Organization of the American Society of Mechanical Engineers, and Dr. Charles Warren Hunt, Secretary of the American Society of Civil Engineers.

The basis of the report herewith is the work of the four sub-committees which were appointed at the November meeting and the main subdivisions represent approximately the scope of the sub-committee work.

A. RELATIONS WITH OTHER NATIONAL SOCIETIES AND RELATED ORGANIZATIONS.

It is the opinion of your committee that the identity of the four existing national societies should be preserved.

The committee believes that the American Society of Civil Engineers should continue to pursue the objects for which it was formed as expressed in the constitution, namely:

"The advancement of engineering knowledge and practice and the maintenance of a high professional standard among its members" and that it should devote its chief endeavors to the performance of these objects. It feels, however, that the time has now come when this society should adopt the principle of becoming an active national force in economic, industrial and civic affairs. This can only be done effectively, however, by active co-operation with other engineering organizations of the country.

To this end the committee recommends that a comprehensive organization be formed embracing:

First—The local affiliation of the branches of the national technical societies and the local technical societies.

Second—A state council composed of representatives from the local affiliations.

Third—A national council consisting of representatives of the national technical societies and of the state councils or state group organizations in lieu thereof.

The object of the council shall be to increase the usefulness of the engineering profession, to bring about greater co-operation and to advance the welfare of engineers.

The council shall have an executive committee, shall maintain a central office and shall hold at least one meeting each year. It would be desirable that a bulletin of general engineering interest be published by the council. The council shall be supported by a per capita contribution or in such other manner as may be determined.

B. INTERNAL RELATIONS AND LOCAL ASSOCIATIONS.

Your committee makes the following recommendations:

1. Local Associations:

(a) That every member of the society be a member of a local association.

(b) That there be created in each geographical district of the society an organization consisting of representatives of the local associations in that district.

(c) That local associations and district organizations shall operate under uniform constitutional provisions to the extent only that the same are necessary or desirable to insure uniform relations with the society.

(d) That the representatives of each district on the Board of Direction and the Nominating Committee of the society be elected by ballot by the corporate members resident in such district.

(e) That it be the duty of each director to visit each local association in his district at least once during each calendar year.

(f) That the Nominating Committee select candidates for the offices of president, vice-presidents, and treasurer, the election of which officers shall be by the ballots of the corporate members.

(g) That there be an annual conference of representatives from the local associations for the purpose of discussing the welfare of the society and its members.

(h) That there be allotted a percentage of the dues of the society to each district organization and each local association for the payment of their expenses.

(i) That the Board of Direction refer, for recommendation, each application for membership to the local association in whose jurisdiction the applicant resides.

(j) That the present provisions of the constitution relating to the discipline and expulsion of members be so revised as to make them more effective.

(k) That it be the obligation of each local association to bring about within its territory a close affiliation of all branches of the national and of the local technical organizations for the purpose of advancing the status of the engineer.

(l) That in communities where members are too few to form a local association, it be their obligation, in addition to that of their district local association, to affiliate with the resident members of other technical societies, and other engineers, where such affiliations will promote the organization to a local affiliate body.

(m) That the local affiliations be the basis for comprehensive state and national organization.

2. Rearrangement of Grades:

That the grades of membership be more clearly defined and that changes be made in the grades of Associate and Fellow.

3. Student Societies:

That it be the duty of the local associations to organize and assist student engineering societies in neighboring engineering schools, to provide carefully selected speakers, and to maintain personal contact with such societies.

(Note: The above is recommended in lieu of establishing the grade of student member and of establishing student branches.)

4. Young Men of the Profession:

That it be the duty of the local associations to provide for the welfare of the younger members of the profession by:

(a) Reasonable representation on the active committees.

(b) Encouraging their discussion of the general problems of the society.

(c) Arranging excursions to works of engineering interest, and

(d) Promoting social intercourse between them and the older members.

5. Personal Service:

That a personal service bureau be maintained by each local affiliation, so organized as to operate in connection with a central service bureau to be maintained by the national council.

6. American Engineers in Foreign Service:

(a) That it be the duty of members resident in foreign countries outside of North America to form associations and to promote an affiliation with the resident members of other American technical societies.

(b) That the Board of Direction consider the feasibility of keeping on record, and providing to American consuls abroad, the names, addresses, and brief professional qualifications of members of the society resident abroad.

C. TECHNICAL ACTIVITIES.

1. Meetings:

That local associations should hold not less than four stated meetings per year and encourage joint meetings with kindred societies.

That the fortnightly meetings of the parent society should be discontinued.

That the semi-annual meetings of the parent society should be supplemented by the addition of a spring and a fall meeting held successively in different sections of the country under the auspices of a local association.

2. Papers:

That the present system of securing papers depends wholly upon voluntary offers and results in a limited variety of subjects. Committees of the parent society and local associations should be formed and charged with the responsibility for promoting greater activity and discussions. Simultaneous discussions of important papers by local associations is desirable.

That the use of the monthly *Proceedings* should be extended to include editorial work, abstracting and reviewing important engineering articles and subjects of popular interest to the great majority of engineers.

3. Committees:

That there be created advisory standing committees of the Board to promote the study of important engineering subjects and charged with outlining and co-ordinating the work of like committees of the local associations. Three members of the Board should constitute a standing advisory committee on each subject. Local associations should urge the younger members to identify themselves with local committee work.

That local associations should suggest names of volunteers possessing necessary qualifications for special committee service, and that tenure of committee membership shall terminate automatically on account of absence or inactivity.

That the society support an active program of research work, co-operating, if practicable, with existing research agencies.

That the chairmen of the standing advisory committees of the board should constitute the Publication Committee.

That to effectively carry out the intent of these recommendations, a technical editorial staff under the direction of the Publication Committee should be established.

4. Sections or Divisions of the Society for Specialized Lines of Work:

It is not recommended that the work either of the parent society or the local association be divided in this way. The object apparently sought by such divisions will be better met by the work of strong committees.

5. Co-operation with Specialized Engineering Societies and Other Organizations:

Much of value has been accomplished in the past in this way and it is recommended that such work be continued and extended.

6. Standards in Engineering Practice:

There exists at the present time a committee known as the American Engineering Standards Committee, composed of representatives of the national engineering societies. This line of co-operation and advice is approved and it is recommended that it be continued and extended, but the idea of developing this committee into another association is deprecated.

It is recommended that a book of recommended practice and standards be compiled which will be revised periodically to follow the development of engineering.

D. RELATION TO PUBLIC AFFAIRS.

1. Definition of Engineering:

That the three main ideas in a complete definition of engineering should be as follows:

(a) A general and descriptive statement.
(b) The content of the profession—the things that engineering does.
(c) The aims and motives the profession should have.

2. Ethics:

That a short code of ethics of broad scope, general character, and positive rather than negative injunction be prepared.

3. Engineering Education:

That a standing committee of seven be created to consider questions of educational policy, and offer advice and guidance in carrying out

such policy. The aims of engineering education, fundamental requirements, changes in curricula, indicated by changing social and industrial conditions, the qualifications of teachers, and the standardization of degrees are a few of the topics which such a committee should rightly consider. Further, that local associations appoint similar committees of three or five to co-operate with educational institutions in their respective territories.

4. Licensing:

That the society in co-operation with the other founder societies prepare a standard form of bill for the licensing or registration of engineers, to be used in the framing of legislation.

5. Arbitration and Expert Testimony:

It is the belief of the committee that the present practice with regard to expert testimony and arbitration is not satisfactory, and it is recommended that a committee of the American Bar Association be asked to co-operate with the joint committee from the four founder societies in order to develop better practice along these lines.

6. Publicity:

It is recommended that the preparation of general articles on engineering subjects be encouraged and assisted by the profession, especially with a view toward having such articles published in the standard magazines.

7. Legislation and Development of Natural Resources:

It is recommended that the national council maintain an agency in Washington, D. C., or elsewhere, for the purpose of keeping advised of all proposed federal legislation and departmental rulings and regulations involving directly or indirectly questions of engineering; and that such agency keep the society or its locals advised from time to time of such matters. It shall also be the duty of the various locals to keep advised on all proposed state legislation affecting engineering matters and the said locals shall actively interest themselves to the end that proper legislation may be enacted. It is also recommended that such agency and the state and national councils shall keep advised as to the proposed creation of federal and state commissions, whose activities may affect engineering enterprise; and that the influence of the locals and the society at large shall be directed towards securing the appointment of engineers upon such commissions.

8. The Service of the Engineer to the Community, State and Nation:

The engineering profession owes a duty to the public which it is believed can best be discharged by the active participation of every

engineer in the civic work of his locality. To this end it is urged that the engineer join the civic body of his community, and if there be no such organization, that he should then endeavor to organize the community for civic work in sympathetic co-operation with the governing body. The engineer's duty to the public also requires that he give his best efforts to matters of state, interstate and national character, calling upon the various engineering bodies for assistance and co-operation when necessary.

9. Patent Law:

Inasmuch as a nation-wide society of inventors has been formed, composed largely of engineers, one of whose objects is to handle the subject of patent law, it is recommended that no action be taken on this subject at the present time.

10. Co-ordination of Government Activities:

It is recommended that the influence of the entire membership of the society be directed toward the creation of a federal department of public works, the secretary of which shall be technically qualified and a member of the president's cabinet, and that the law creating such department shall provide for the co-ordination of all government engineering activities.

11. Industrial Affairs:

That fundamentals of industry and their inter-relation are based on engineering principles which should form a part of the education of the engineer.

JOINT CONFERENCE COMMITTEE.

In accordance with the similar action of the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Institute of Mining and Metallurgical Engineers, a joint conference committee was appointed consisting of:

Gardner S. Williams,
George G. Anderson,
Richard L. Humphrey.

The Committee on Development submits this report in accordance with the following resolution:

Whereas, The Committee on Development in considering the subjects assigned to it has arrived at certain fundamentals which it is anticipated will form the basis of its ultimate report;

And Whereas, the Committee thinks it desirable to have a discussion of these fundamentals by the membership of the society; therefore, be it

Resolved, That these fundamentals be submitted to the Board of Direction with the request that they secure the views of the membership thereon.

Respectfully submitted,

ONWARD BATES,
Chairman.

E. T. HOWSON,
Secretary.

Minneapolis, Minn., June 16th, 1919.

"I have only been on the Board a little over a year but during all of that time I have never once seen a disposition to center anything at New York that could possibly be done outside. Of course, there are matters in which close attendance at the meetings is desirable, and there are some emergency matters in which local people only can be selected on account of lack of time and the uncertainty of getting the attention of outlying members, but these are the only instances, and proper instances, of exception to the rule."

He speaks in detail as to the purely temporary financial condition of the Society, the reasons which led to it, etc., and then continues:

"With reference to Mr. Charles Warren Hunt as Secretary, I may say that however you may feel personally about him, as a man certainly you must admit, as I have had to admit, that he is a most efficient executive and as keen a business man as the Society ever had for Secretary. For a profession which is always grumbling about its compensation, to turn around and grumble about the compensation it will pay to so satisfactory a man, who holds the welfare of the Association in such good shape, due to his executive and business ability, is, to my mind, wrong. Let those among us who can well afford to ask other people to be generous to us with emoluments, be generous towards others. Mr. Hunt has not always succeeded in retaining as his personal friends every member of the Society, but I have never heard of anyone who was convincingly able to prove that he was not an excellent business man, an efficient organizer, and an efficient Secretary. Certainly my own observation of his work during the past year has convinced me that he is well worth all that we pay him. The work of the Society is very much greater than anyone can possibly imagine it to be."

Perhaps I may be held to be immodest in reading this statement, but my reason for so doing has been previously given. In addition to this, similar criticisms to those of Mr. Alvord's friend have been frequent for many years, and to my knowledge were used long before my official existence. Within the last few months, statements of the same general tenor were made and published in an anonymous communication signed "M. Am. Soc. C. E." in *Engineering News-Record*—not only referring to me but to the secretaries of all of the Founder societies. The editor of that journal when the Board of Direction asked for the name of the individual, exercised his editorial prerogative, and said that the writer of the anonymous letter objected to the disclosure of his name, adding: "You doubtless can appreciate his feelings and sentiments in the premises."

Mr. Alvord continues:

"I have given a great deal of attention to the present unrest in the engineering profession. The most of our troubles come from self-centered narrowness, and what the engineer of today lacks is breadth of view, less envy and jealousy, and more interest in the business and political world. I have been greatly impressed in the last few years—and I have now been practising my profession for nearly 40 years—with the fact that envy and jealousy are at the root of a great deal of engi-

neering discontent. We begrudge other people their success. We begrudge the heads of our profession their notoriety, and we tear down other people's reputations in our profession altogether too freely and thoughtlessly. We should, I think, pay particular attention to those members of our profession who have done good work. It does no harm to praise them a little, and it is a good way to make friends. The engineering profession will never grow big and broad until its members' mental attitude grows big and broad.

"I have written you very frankly and fully, because I think in answering you I am answering a number of other men who have had erroneous impressions of the attitude of the New York membership, and, particularly, the leading members on the Board of Direction toward the outlying members."

If I am not very much mistaken the original idea of the Development Committee of the American Society of Civil Engineers was the development of the Society itself to meet existing and changed conditions due to the war, etc., and that to its duties was added later the question of co-operation with other bodies for the general good.

I have not been asked, as I understand it, to come here with any suggestion as to improvement in methods of the Society's work, nor do I know to what extent the Committee has decided on suggesting fundamental changes, but I believe that it is entirely proper for me to discuss that part of the problem which relates to the co-operation between organizations, inasmuch as that has nothing whatever to do with the management of the American Society of Civil Engineers. I have therefore ventured to write out, as briefly as possible, a statement of my views, based upon a great deal of careful thought and considerable knowledge of conditions both at headquarters and in various parts of the country.

There are in my judgment two entirely separate phases of the general subject of the condition of the Engineering Profession.

(1) The theoretical, scientific, educational side, which includes the maintenance of high professional and ethical standards, and

(2) The welfare side, which includes all matters relating to the Profession outside of those in No. 1. This means not only the participation of the Engineer in civic and community affairs, but concerted action connected with National, State and Municipal problems, in which the welfare of the members of the Profession both individually and collectively is concerned, such as professional rates of pay, employment of engineers, and all legislation which affects the Profession either locally or nationally.

In my opinion, these two lines of effort cannot be carried on together. The National Engineering Societies are well organized for, and can carry on, the first of these, and they should not be interfered with nor hampered by being forced to undertake the second.

REPORT OF THE DELEGATION OF AMERICAN ENGINEERS

TO THE

AMERICAN SOCIETY OF CIVIL ENGINEERS
AMERICAN SOCIETY OF MECHANICAL ENGINEERS
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
AMERICAN INSTITUTE OF MINING ENGINEERS

The Delegation of American Engineers, constituted by your Societies to visit France in December, 1918, in acceptance of the invitation extended by the Congrés General du Génie Civil, beg to submit the following report and an account of its mission.

As constituted by your Societies, the Delegation consisted of the following members:

Representing the American Society of Civil Engineers:

James F. Case, Chairman of the Commission,
George F. Swain, Past-President,
Nelson P. Lewis, Vice-President,
George W. Tillson, Treasurer,
George W. Fuller, Past-Director,
A. M. Hunt, Director.

Representing the American Society of Mechanical Engineers:

Charles T. Main, President.

Representing the American Institute of Electrical Engineers:

Lewis B. Stillwell, Past-President.

Representing the American Institute of Mining Engineers:

E. Gybbon Spilsbury, Past-President.

The Delegation organized on the way over by the choice of Maj. James F. Case as Chairman, and George F. Swain as Secretary, and by the organization of the following Committees, the Chairman being *ex officio* a member of all the Committees:

1.—*Committee on Commercial Ports.*—Messrs. Case, Chairman, Main, Spilsbury, Hunt.

2.—*Committee on Water Power.*—Messrs. Stillwell, Chairman, Hunt, Main, Swain.

3.—*Committee on Navigable Waterways.*—Messrs. Swain, Chairman, Main, Spilsbury.

4.—*Committee on Roads.*—Messrs. Tillson, Chairman, Lewis.

5.—*Committee on Technical Education.*—Messrs. Swain, Chairman, Main, Stillwell, Spilsbury, Hunt.

6.—*Committee on Agricultural Development.*—Messrs. Fuller, Chairman, Lewis, Tillson.

On arriving at Bordeaux, on December 16th, 1918, the Delegation was met by S. D. Brown, Assoc. M. Am. Soc. C. E.; and on arriving in Paris the same day, it was joined permanently by the following attachés:

Capt. P. Charton, of the French Engineers, Delegate of the Commissariat-General to accompany the Delegation and serve as Liaison Officer; Capt. Carpenter, of the American Army; Mr. S. D. Brown; and Mr. George Herdt, representing the Society of Civil Engineers of France.

These gentlemen were of the greatest assistance to the Delegation during its stay in France, and the Delegation cannot sufficiently express its obligation to them.

The Congrés General du Génie Civil, representing engineers, manufacturers, and public men, interested in the problems of engineering, had held meetings in March, 1918, at which a large number of papers had been presented and discussed. The Congrés had considered and published these papers and had passed resolutions with reference to a large number of them. On the way over, the members of the Delegation had read the papers relating to the subjects of their Committees, and were prepared, therefore, to discuss them and the resolutions with the members of the Congrés.

The object of the visit was to discuss with the French engineers the large engineering problems now facing France. Many of these were treated in the papers presented to the Congrés, while other matters were brought up before the Delegation. The Delegation was also offered the opportunity to visit various parts of France, to see the harbors, the water powers, many large engineering works, and some of the regions devastated during the war.

The visit of the Delegation was occupied as follows:

December 16th to December 26th, 1918.—At Paris, holding Committee meetings, visiting certain industrial establishments, and meeting the French engineers.

December 26th.—Left Paris in the evening for Nantes.

December 27th.—Visit to the Port and City of Nantes.

December 28th.—Left Nantes by boat for St. Nazaire. Visit to the Port and City of St. Nazaire. Left in the evening for Paris.

December 29th, 1918, to January 4th, 1919.—In Paris, visiting schools or industrial establishments, or holding meetings, with the exception of two days which were devoted to visiting the front; the first day to Albert, Arras, Lens, and Amiens, and the second day to Chateau Thierry and Soissons.

January 4th.—Left in the evening for Grenoble.

January 5th and 6th.—At Grenoble, visiting hydraulic works, or holding meetings with the Chamber of Commerce.

due to the added demands made on the French railroads for rationing the armies of occupation along the Rhine and the civilian populations of Belgium, Alsace, and Lorraine, to say nothing of the movements of troops on leave, bound for Central and Southern France.

With reference to rehabilitation, as applied both to the devastated area and to war industries, there was an inactivity which at first seemed surprising even to the point of suggesting apathy. Further contact with conditions in France, however, showed that this was a natural result of the uncertain knowledge on the part of those interested as to what reparation and indemnification would be received, how it would be distributed, and what work should be undertaken. Actual rehabilitation depends on available funds, and programmes can be definitely formulated only when this is settled.

One phase of the situation in France should be kept in mind, particularly by the American who may characteristically anticipate that rehabilitation work should begin coincident with the cessation of hostilities. This is the fact that the period of the Peace Conference is also a period of quiescence immediately prior to parliamentary elections. Normally, the spring of 1919 would see the election of a large number of members to the French Senate and Chamber of Deputies. Under the French law, the soldiers cannot vote while mobilized. To disfranchise them from a National election is unthinkable. To allow them to vote at the front, or wherever they may be mobilized, requires a new law which has not been passed for a number of reasons, one of which is that the members of Parliament who will continue in office until their successors are elected, are awaiting news as to when demobilization will occur.

For the reasons pointed out, neither the American Delegation nor the recent Congress of Civil Engineering at Paris dealt with the programmes of readjustment or with those of rehabilitation. Their work related solely to the problems of reconstruction. That these problems are of the greatest magnitude and seriousness for France will be evident when it is remembered that, after the Peace Conference specifies the terms of peace and indemnification, and war credits cease, it is estimated that France will have annual Governmental budgets several times those before the war.

There can be no doubt that, after peace conditions rule, there will come a period of strenuous commercial struggle. To prepare for this, the French Congress of Engineering desired to ascertain from the American Delegation what American experience suggests, and hereafter may suggest, as to procedures helpful to both nations, and especially how France could meet its colossal problems. Co-operation between France and the United States was the watchword throughout.

Engineering problems in their restricted technical sense came up for discussion practically not at all, for the excellent reason that the

French do not need advice nor assistance along strictly scientific lines. It was in the larger and economic aspects of engineering, to aid in building up the industries and commerce of France, that our French associates desired to learn from the experience of the American Delegation.

Committee on Ports and Navigable Waterways.

These subjects were covered by one Committee instead of by two as originally contemplated, with the membership remaining unchanged.

This Committee held three meetings with the French engineers—on December 19th and 21st, 1918, and January 15th, 1919. At the meetings of the Committee, the situation with reference to the French ports was described and, as already stated, the Delegation had an opportunity to visit several of these ports.

Unquestionably, facilities at the French ports were insufficient even before the war; and if, as must be the case, the conclusion of the war results in the re-arrangement of trade routes and a greater traffic between France and other countries, the insufficiency will be still more pronounced after the war, unless immediate means are taken to increase the facilities.

Indeed, France has done much during the war to improve and increase facilities, and, in some cases, the work of American engineers has contributed largely to this end. On the Loire, and on the Garonne, a great increase in facilities offered has taken place, and this, the French engineers state, must be continued. It appears that the experience in carrying on harbor and river works in France has been very similar to that in the United States. All harbor and river works are carried on by the State, by money provided by the budgets. This has resulted in a scattering of resources, a lack of continuity, and a failure to concentrate and carry on important works to completion. The French engineers admit that this was the case, and that their methods must be changed, and that private initiative in each port should be encouraged in works of this kind.

It was also stated that some change in banking methods would also be necessary, the great French banks having taken no part in making funds available for the execution of public works. The Chambers of Commerce of the maritime ports have important resources which have been and can be made available in providing funds. These Chambers of Commerce are authorized by law to issue and guarantee funds for such purposes, in very large amounts, the security being furnished by charges on the commerce of the ports. In this way, the Chamber of Commerce of Marseilles has recently made itself responsible for some 40 000 000 francs for the enlargement of the port and the construction of the canal between the port

The work of the American engineers at Bordeaux was also of great importance in the war, and of great interest as an improvement of the port. They constructed a considerable length of dock along the river, while the French constructed other new docks. These altogether have increased very much the capacity of the port. Before the war, there was a length of 6 500 m. of docks, and 3 500 m. more have been built during the war.

At Marseilles, very extensive works have been planned and partly carried out, including the canal to the Etang de Berre, which will pass through a tunnel having exceptionally large dimensions, *viz.*, length, 7 000 m.; width, 22 m.; height, 14 m., and cross-section, about 360 sq. yd., with a depth of water for barges of 3½ m.

It is contemplated to make at the Etang de Berre, which is a deep water inlet, a port having a capacity of the entire present Port of Marseilles.

Altogether, the future of the ports of France seems to the Delegation to be very bright, if the expenditures necessary for their development are concentrated and expended with efficiency.

France has a considerable system of internal navigation, consisting of canals and canalized rivers. In 1913, the last year for which statistics are available, there were in use 4 025 miles of canalized rivers, and 3 050 miles of canals, almost all of which were operated by the State.

On all these canals which belong to the State, there is free navigation without any charge. The State pays the interest on the cost, and also the cost of maintenance. Under such circumstances, the cost of transportation by canal and by railroad is, of course, no indication of the relative economy of these two methods of transportation.

The Commission has been impressed with the situation just explained and the fact that works of interior navigation, like harbor works, are constructed by the State. Many French engineers, like many in this country, and other countries, seem to be greatly attracted by projects of interior navigation. They certainly offer interesting fields for engineering design and construction; but more important than engineering design and construction is the economic study of the works proposed. We have had in the United States many illustrations of the waste of public money for such projects. We have seen some of the States obliged to repudiate debts contracted for canals, and the abandonment of almost all our canals. We fear that in France and elsewhere, there may be some danger of a similar waste of resources; and while there is no question that canals, where economically justified, may have great value, we have urged in our preliminary report that every new project should be thoroughly studied from the economic point of view, taking account of all elements of expenditure and all

sources of income, including, of course, any interest or maintenance charges paid by the public directly or by taxes.

In America, it may be stated with fairness, works of internal navigation have not as a rule been successful. The conditions in France, however, are more favorable, because there is less interference of traffic, and because some of the rivers, especially in the north of France, have very favorable slopes. Nevertheless, it is important to remember, in France as well as in America, that when the State, that is to say the people, pays all interest and maintenance charges, and when this fact is ignored, the people may be burdened with expenditures for public works that are economically unsound. The cost is always paid by somebody, and when transportation facilities are to be improved, the comparative advantages and disadvantages of railway and canal should be carefully considered, every item of cost being included in both cases.

The existing canals in France, should be utilized, of course, to the full extent that they are economically utilizable. Some of the waterways, particularly the River Seine, have been of great service during the war. The Seine, however, in some respects is a special case, not representative of conditions found elsewhere. Great quantities of coal and other heavy material are brought from abroad, notably coal from Wales, to the mouth of the river, and carried up to Paris in barges.

In the flat country in the north of France, canals may be the most economical means of transportation, even taking into account all elements, whether paid by the State or by others, but the south of France which is far from flat, is quite different, and it does not necessarily follow that canals and river improvement would be economical there.

It is obvious that transportation is a case in which the law of increasing returns is particularly applicable. When the means of transportation are once provided, an increase of business can be handled with much less than a corresponding increase in expenses. If both means of transportation, namely, rail and water, are provided between given points, neither will be able to do the work as cheaply as one means alone could do it.

Inland waterways cannot transport all kinds of material in a way to conform to modern requirements, as, for instance, perishable goods and others which require speed.

Railways, however, can transport all kinds of material. Where there are large quantities of heavy material awaiting transportation, which need not be carried rapidly, if transhipment is not necessary and if topographical conditions are favorable, the construction of a canal may be economically sound, but even under these favorable conditions the comparative advantages which would result from investment of an equal sum in improved railway facilities, should be carefully

1865. The labor employed at the time of our visit included a very few French men, a considerable number of French women, a large number of Annamites, a few Arabs, and some German prisoners.

The establishment of Fredet at Brignoud, which began operation in 1868 as a paper mill, has been greatly expanded during the war. Recently, a large addition has been made for the bleaching of cotton from rags. This has been used as a raw material in the manufacture of high explosives. Four 1 500-h. p., calcic-carbide furnaces are in operation, and several much larger furnaces are approaching completion, as is also a plant for the manufacture of cyanamide. In design and construction, the newer buildings of the Fredet establishment and their equipment are in every respect admirable.

In the Valley of the Romanche, the Société Electrothermique Keller-Leleux is installing a power plant which will utilize in one step a fall of 1 100 m. The diameter of the pipe is 50 cm.

Another development of interest is the manufacture of iron pipe by electrolytic deposit of iron on revolving cylinders.

In the vicinity of Grenoble, factories exist for the manufacture of caustic soda, chlorine, aluminium, carbide of calcium, cyanides, nitric acid, ferro-alloys of many kinds, magnesium, sodium peroxide, explosives, chlorates, cyanamide, and nitrogenous products. Before the war, about 90 000 h. p. was used in producing aluminium. In June, 1918, carbide of calcium was produced by a group of factories using 42 000 h. p., and producing about 45 000 tons per annum. Nitrogenous products, including cyanamide, were being produced at a rate of 4 000 tons per annum. Plants manufacturing shells, cartridges, military wagons, and other material for the French Army, were employing 25 000 hands and using 20 000 h. p.

The stimulus of war conditions is said to have resulted in the development of a method of enriching the flame produced by the local coal with a spray of heavy oil, thus solving the problem of utilizing for metallurgical purposes the coal of the region, which is far from being rich in volatile matter. It has resulted also in the installation of a considerable number of electric furnaces.

The time available to the Delegation did not permit a visit to the region of the Pyrenees. The impetus toward water-power development has been felt in this region, and several important plants are now in operation, including one of approximately 20 000 h. p. and another of 32 000 h. p. The Committee was informed, also, that two projects are under way in that region, which will use for transmission purposes a potential of 120 000 volts, though the highest hitherto used in France is 60 000 volts.

The third water-power district, as has been said, is that of the massif of the south central part of France. This region is extensive in area, and there are a number of streams of high aggregate fall, but these

streams are not large, and the power possibilities of the region are by no means comparable with those of the Rhône.

In the years immediately preceding the great war, the annual consumption of coal in France was something over 60 000 000 tons. Of this amount, approximately one-third was imported. The average price then was from $5 to $6 per ton. It is probable that in the future the price will be materially higher, probably about $8 per ton. It is obvious, therefore, that France should develop her water power as rapidly as practicable, since the great lack of the country is coal.

The Engineering Congress at its session in March last adopted recommendations looking to the standardization of frequency and voltage. It was recommended that 50 cycles per sec. be adopted as the standard frequency, and that the use of 25 cycles per sec. be permitted in special cases.

Although the Orleans Railway Company began in 1900 the operation of trains by electric locomotives between the Austerlitz Station and the Quai d'Orsay, and the Western Company in the following year electrified its line from the Invalides Station, Paris, to Versailles, comparatively little has been actually accomplished toward the further electrification of the railways of France. Careful studies by the engineers of several of the railway companies were in progress before the war, and it is expected that they will be resumed in the near future. We were informed that a commission representing three of the French railways will visit the United States in April and May, 1919, for the purpose of investigating the electrification of railways as developed in this country.

In general, French factories are equipped to construct all the electric machinery and apparatus which may be required, except, perhaps, certain electric railway equipment and turbo-alternators of the larger sizes, and even as regards these it would seem necessary only to add to the tool equipment of their factories, as there can be no question of the skill of their engineers and designers.

As regards water power legislation, France is in a position to-day very much like that in which we in America find ourselves. A general water power bill is before the House of Deputies. In view of the present realization of the importance of water power development, it is expected that a general bill governing water power concessions will be promptly enacted, and that its provisions will be attractive to capital. Hitherto, water powers have been developed either under governmental authorizations which are revocable, or under special concessions for a fixed term. In general, the terms of the concessions have been more favorable to the investor than those advocated by the so-called conservationists in the United States. While the authorizations are revocable, we are informed that revocation has never occurred

climate of the Northeastern United States to that of California, which is dry.

3d.—Road surfaces of Portland cement concrete have attracted attention for many years. They are of particular value in the neighborhood of plants which manufacture the cement, in consequence of which the material is cheap in their construction. The skill required for the production of good concrete is most essential, but large areas of surface of this type have been constructed in recent years. The concrete possesses the advantage that if laid at a proper grade it can be used as a foundation for all the types of roadways after its original utility has gone.

4th.—Road surfaces of vitrified bricks are serviceable when the bricks are of the best character, but only in regions where suitable clays for their manufacture are available and where brick plants are in existence. They are much more expensive than the types which have been previously mentioned and can hardly be considered in the problem of road construction in France.

On these conditions, one cannot expect the Communes, the Departments, and the State, to find immediately after the war the necessary capital. The old system must be entirely given up. Consequently, the extremely useful work of repairing our road system can only be done through the medium of private enterprise which would find the capital, enter into agreement with the Communes, the Departments, and the State, and undertake the construction of some well determined portion of road, guaranteeing the maintenance of the same during a certain number of years, an annuity including the former yearly price of maintenance, increased by the present greater value, and even of an excess if justified by the improvement being provided for. It will be then advisable to ask the American engineers how the road budget problem has been solved in America, and to examine in what proportion we could apply in France the American solution.

To these our Committee made this reply:

Referring specifically to the tentative conclusions of the French members of the Committee, submitted at the first meeting held on December 20th, 1918, the American Delegates would say as regards methods of construction:

1st.—That they heartily agree with the proposition that broken-stone roads have been found to be unsatisfactory for motor vehicles of heavy weight and great speed, and that, consequently, this method of construction should be given up for road surfaces carrying a large amount of traffic. This conclusion has been reached in America, and what is known as water-bound macadam is sometimes used, but only where a temporary roadway is required.

In arriving at this conclusion, the American Delegates wish it to be clearly understood that they recognize fully the value of these water-bound macadam roads during the recent war; that, while they did suffer materially under a heavy traffic, their character was such that repairs could be quickly made, and the roads kept in almost continuous use. This, of course, was expensive, but, in times of war, quick results are necessary, rather than economy, and construction

methods are perfectly proper and justifiable that would be very extravagant in times of peace.

2d.—That they fully agree with the conclusion that surface applications of bitumen to broken stone surfaces have not been satisfactory for heavy traffic, but that a more satisfactory surface known as "asphalt macadam" can be constructed by what is known as a "penetration" system, and that it can be laid in the way referred to so that good results can be obtained. In the construction of bituminous concrete pavements, a much more elaborate plant is required, which naturally makes the cost of the road surface more expensive. It is probable, however, that the extra cost is justifiable on account of the greater durability of this class of pavement.

In the memorandum it is stated that experience has demonstrated that this kind of pavement will stand heavy traffic for ten years or more, if carefully constructed. The American Delegates think this is a rather optimistic view. It depends, however, on just what is considered "heavy traffic". The word "heavy", as applied to traffic, is a very indefinite one, for with the increased weight of trucks that have been in use during the last two or three years, what would have been considered heavy traffic five years ago would be medium traffic at the present time.

3d.—The statement that the highest type of asphalt surface is that constructed with a mineral aggregate of sand of very fine nature, to which a proper quantity of dust and asphalt is added, is undoubtedly correct for a city pavement. It is, however, exceedingly doubtful if such a pavement would withstand the heavy units of motor traffic that are in use at the present time and likely to increase in the future.

4th.—That, as to the use of brick for road construction in France, they feel some hesitancy in making any recommendations, as they are unfamiliar with the character of shales and clays in France.

The American Delegates were asked for an expression of opinion as to the methods of financing road improvements in France, and the possibility of inducing private companies or contractors to undertake such work, receiving their compensation in a number of annual installments, fifteen such payments having been suggested.

It is probable that there are American companies or contractors who would be ready to finance road improvements with their own funds and accept payment in a number of annual installments—provided they are given entirely satisfactory guarantees of payment. It must be pointed out, however, that they would be obliged to borrow the money, thus paying a higher rate of interest than the State, and that they would expect a larger profit and a good rate of interest on all their carrying charges—so that the amount of work done for the same total expenditure would be much less than if they received prompt payment in full and release from their obligations. The credit of the State would be better than that of the private companies, and it would seem that it should be availed of, in order to secure satisfactory results with a minimum of expenditure and in the shortest possible time.

Special attention was called to the folly of providing funds for road improvement by the issue of long-term bonds, running for a

financed. These consisted of forms of contracts and specifications of the New York State Highway Department, covering the construction of all kinds of roads built in that State, a copy of the "Final Report of the Special Committee of the American Society of Civil Engineers on Materials for Road Construction and Standards for Their Test and Use", and proof sheets of several sections of the "American Highway Engineers' Handbook", then in press, containing exhaustive descriptions and discussions of materials and methods, as well as the manner in which such improvements are financed in rural and urban districts.

After an exchange of views, the following conclusions were unanimously adopted and presented to the Congress:

1. Broken stone roads, which formerly were deemed suitable even for city streets, are soon damaged by motor vehicle traffic, to which they are not adapted. The tarring, which has mitigated the nuisance from dust, only very insufficiently preserves the road surface from the wear and tear due to the travel of vehicles with mechanical traction.

2. New systems of construction have been developed, the most successful, perhaps, being cement concrete and bituminous and brick surfaces. Experience extending over a sufficient number of years has shown that the preference to be given to one or the other of these various systems of construction depends on several factors: climate, intensity of travel, cost price, etc. The brick surfaces used in America could only be used in exceptional cases in France. Cement concrete roads are only advisable in countries where the materials used in their composition are at hand at advantageous prices.

3. Roads constructed with bitumen or asphalt aggregates are, unfortunately, very expensive, but they have the advantage of requiring less maintenance than broken stone roads. For an equal travel intensity, they answer much better the exigencies of the travel of motor vehicles.

4. The cost of laying these roads is considerably lowered when this system of construction is applied to broken stone roads, the old broken stone constituting a good foundation.

5. The reconstruction of the French road system is necessary on account of its great deterioration due to the travel during the war. It would be folly to restore this system as it was before, as it could not withstand the traffic of motor vehicles, which will grow rapidly to meet industrial and commercial requirements, as well as those of tourists, and the expense of maintenance of broken stone roads would greatly increase without giving satisfaction to those who use them. Happily, most of the French roads will make excellent foundations to which it will be sufficient to apply appropriate wearing surfaces. Under these conditions, it will be possible to adapt the roads to the new requirements without incurring very great expense.

It would be logical that the expenses relative to the improvement and maintenance of the roads should be borne by those who use them, and the abutters who profit by the travel. This principle, admitted

and applied in some foreign countries, permits the issue of bonds for the improvement of roads, the capital being guaranteed by taxes and revenues which are certain and which increase with the intensity of the travel, as, for instance, taxes on motor cars, on gasoline, etc. Unhappily, the fiscal laws in force in France do not allow this procedure, and, as it is not possible to count on voluntary contributions, it is necessary to have recourse to the budget of the State, "Departments", and "Communes", in order to obtain the necessary allowances to bring the road system to a state capable of meeting the new requirements.

If, however, the State, "Departments", and "Communes" could not find the necessary capital, private enterprises might be organized to undertake the construction of some well defined portions of roads, guaranteeing their maintenance during a certain number of years, with the proviso that an annuity, including the old yearly price of maintenance increased to cover the new conditions, and a further sum representing the value of a prompt realization of the benefit of the improvement, should be provided, in addition to the cost of construction.

Though this proceeding may be more expensive than direct construction through the Public Works, it will be necessary, perhaps, to have recourse to it, on account of the circumstances created by the war.

The study of the financial question must be pursued in subsequent discussions, with the co-operation of persons qualified to give useful advice.

Agricultural Industries and Rural Hygiene.

This section, under the chairmanship of M. Risler, discussed and compared French and American experiences and viewpoints concerning topics set forth at length in the Proceedings of Section VII of the Congress of March, 1918. Much information is also to be found on financial, organization, hygienic, and public welfare questions in the work of other sections, particularly Sections VIII, IX, and X.

The French members summarized these papers, explained the prevailing viewpoints of last March, and supplemented them with later data and views in three reports as follows:

1. Organization of an Agricultural Bank, by M. F. Mainié.
2. Agricultural Industries in France, by M. E. Barbet.
3. Agricultural Equipment and Rural Hygiene, by Capt. G. Coupan.

Banking Facilities.—In France there has existed for many years a law whereby the National Government has provided loans to small farmers effecting a co-operative association. Such loans have not been especially popular, and it is considered that the laws are too restricted to allow French agriculture now to secure the working capital needed to meet the demands which the war has placed upon it.

Fortunately for France, its farming lands are mortgaged only to a small extent. It is believed that laws should be adopted, whereby long-term loans can be made safely and conveniently on the basis of

of a rational fermentation procedure, tending to lessen the proportional output of indifferently fermented wines.

What has been said of wine, as to variable output in quantity, is still more true of cider which shows a range of ten to one between maximum and minimum output, for example, the years 1917 and 1918. It would have been of marked advantage in 1918 to have had concentrated apple juice from 1917, when the fruit was so abundant that one did not know what to do with it.

The drying of fruit and vegetables on a large scale is an industry which has been scarcely undertaken in France, although considerable progress has been made in America, especially with the dried fruits of California.

Agricultural Equipment.—In round numbers the available data indicate that, in 1914, the total value of French farm machinery was between 4 000 000 000 and 5 000 000 000 francs. The pre-war imports are placed at about 100 000 000 francs annually, which is also the figure given by some estimators for the value of the French output of farm equipment. Others consider the latter figure to be too low, and believe that 150 000 000 francs is a fair yearly figure for French production in the past, if regard is paid to hardware and metal work on carts, harnesses, etc. With the imports, this makes 250 000 000 francs as the annual consumption of farm equipment.

Capt. Coupan, Engineer of the French Ministry of Agriculture, requested that announcement be made in America of the pressing needs of the invaded area for farm equipment, for which his recent estimates, with comparisons of the normal annual output of French factories, are as follows:

51 000	Double Belgian plows
20 000	Plows with a fore-carriage
13 000	Plows with several wheels
56 000	Scarifiers and tillers
88 000	Harrows
50 000	Rollers
48 000	Grubbing spades used with horses
16 000	Beet-pullers
36 000	Sowing machines
13 000	Fertilizer distributors
34 000	Mowing machines
18 000	Rakes used with horses
21 000	Hay spreaders
8 000	Harvesting machines
24 000	Binding machines
114 000	Vehicles (different kinds)

12 000 Threshing machines (used with horses; inclined plane system)
8 000 Threshing machines used with motors
3 400 Threshing machines for work on a large scale
40 000 Weighing machines for grain
9 000 Self-binders
53 000 Root-diggers

without counting the stone crushers, straw-cutters, pumps, motors, harness equipment, horse-shoes, string for binders, etc.

We can form an idea of what these immediately required implements represent, by comparing the previously mentioned figures with those corresponding to the annual average production of our factories during a few years immediately preceding the last war:

Double Belgian plows	40 000
Divers plows	200 000
Tillers, harrows, rakes	150 000
Rollers	50 000
Fertilizer distributors and sowing machines	18 000
Mowing machines	10 000
Harvesting and binding machines	3 000
Divers materials for threshing machines	3 000

The requirements in some cases exceed the former annual producing capacity of France, which is now reduced about one-third, due to destruction of factories.

In the uninvaded districts of France, it is estimated that more than 50% of the agricultural machinery, owing to lack of repairs and spare parts, is either worthless or in need of extensive repairs.

To what extent Germany can make reparation in kind to help supply equipment to farmers in the devastated area is not now known. The French Government through special bureaus is taking steps to purchase new equipment, with certain appropriations already available, and charging deliveries against a portion of a farmer's estimated indemnity.

French farmers have demanded a wide variety of types of machines, and hitherto French manufacturers have conformed to such wishes. There is a great need of modern methods of standardization, both for types of machines and individual parts thereof. French engineers appreciate this in the interest of economical quantity production. They will encounter resistance from the French farmers, who have strong individual preferences, but now is the time to overcome it.

Some of the French munitions factories will undoubtedly take up the manufacture of farm machinery. Imports at the outset may be helpful in some measure, but, with few exceptions, such as threshers, etc., it is

the view of the French members that the equipment can and should be made in France and adapted strictly to French requirements.

Much is expected of the proposed Agricultural Bank in facilitating this branch of French industry. Some believe that American manufacturers by associating with French makers of farm machinery could work out arrangements that would be mutually advantageous. American experience with some phases of quantity production could probably help the French for a time. Each case would have to be considered on its own merits, as is true of the financial aspects of the proposition. Here, it is to be pointed out that the present French law is understood to require French control to the extent of at least 66⅔% of the securities of concerns in which foreign capital is interested.

The American members were not able to offer much hope for the general use of electricity in rural districts, in competition with combustion engines. As for electricity for heating and lighting in the rural districts, that is a question of economics to be studied on the basis of sound local data for each district.

The French members hope that the proposed Agricultural Bank will be of substantial aid in developing the fertilizer trade with a phosphate rock in Morocco, potash salts in Alsace, and with acid and nitrogen plants built during the war, the latter near the hydro-electric plants of the French Alps.

The French are well informed on scientific agriculture, and the only topic mentioned at the meetings was the work of Whitney on antiseptic treatment of soils to destroy the toxines produced by plant life.

Rural Hygiene.—This is largely a question of popular practical education in the rural districts of France, as is the case in other countries. The French members know well what ought to be done, and steps are being taken systematically to stimulate interest in modern sanitation in the farming districts.

Pamphlets of instruction and advice have recently been prepared by the Association Générale des Hygiénistes et Téchniciens Municipaux, through a committee headed by Col. Bechmann, for 27 years Chief Engineer of the Water Supply and Sewerage Departments of Paris.

Educational methods in vogue in America, especially the efforts of States to accomplish results through conventions of health officers, school teachers, public health associations, etc., were explained. Further data in this respect will be furnished by the American members.

The general welfare and comfort of the farmers and their families was also discussed along the line of moulding public opinion through numerous popular local leaders who are appreciative of local conditions and means of remedy.

The present is peculiarly a fitting time for conducting educational campaigns for making living conditions among the French peasants safer and better. The local press, local schools, and local leaders throughout France should be stimulated on these lines.

A memorandum outlining the news of the American members on the topics previously outlined was prepared and handed to the French members early in January, substantially as follows:

1. Working capital for farmers, to permit them to purchase required mechanical equipment, animals, fertilizers, seeds, etc., should be obtainable from the sale of long-term farm bonds, founded on safe mortgages of sufficiently large co-operative groups of farms, granted under adequate supervision and guarantee of the National Government, with the banks selling such guaranteed bonds given a reasonable commission so as to make it to their advantage to popularize such guaranteed bonds among the investing public.

2. Safe and convenient procedures, with standardized blank forms, for establishing chattel mortgages on movable property, should be provided so as to afford satisfactory collateral or pledge to banks authorized to make loans to the owners for prospective purchases of such property, including industrial equipment, crops, agricultural products, merchandise, etc.

3. A comprehensive and convenient system of warehouse receipts, bills of shipment or lading, acceptances by commission houses, and other documentary proofs of the movements of merchandise in transit from their points of origin to points of destination and payment, should be devised under suitable Government supervision and protected by adequate insurance against loss, so that such records of property may be safely accepted as collateral by banks authorized to make loans to their owners.

4. With amendments made to banking laws so as to permit the convenient hypothecation of property of various kinds, on which loans are sought for periods up to one year or more, it is necessary also to consider time deposits in bank for periods much in excess of 90 days, and to see to it that laws and decrees are formulated in a sound legal manner satisfactory to the banking interests proposing to operate under them.

5. The manner and extent to which the supervision credit and guarantee of the Federal Government of France is pledged to the protection of money lenders should be published in a very clear manner. Likewise, the advantages of ample working capital should at once be made plain to the French farmers, so that they will not be handicapped as compared with farmers of other nations in storing and preserving their products for advantageous sale at home or abroad, in ways which should be given full and wide publicity.

The foregoing suggestions are based on practical experience in America. They deal with certain principles which it is hoped may be of benefit in modifying French banking facilities. Obviously, it is out of the question to attempt here to detail further a subject which is so intimately related to existing laws and decrees in France.

Mechanical equipment for French farmers should be adjusted to the soil, climate, customs, and preferences of France and the countries to which it proposes to export agricultural implements. In adapting munitions and other plants to their manufacture, great effort should be made to standardize types of machines and equipment, and of all parts thereof, so as to facilitate quantity production and thus to secure the resulting economies.

France could adopt to its advantage American methods of establishing in various cattle-raising districts modern slaughter houses and cold storage plants for all meat products. The same is true of a certain number of refrigerator cars for transporting such products from the rural districts to the larger cities. This will require modification of laws and the establishment of effective sanitary supervision of all the branches of this industry, including the central markets.

The drying of fruits and the concentration of fruit juices for shipment and for stabilizing the wine industries are steps worthy of most careful development.

Storage of farm products in metallic containers on the farm and the establishment of central silos or grain elevators of concrete are American customs which seem applicable for use in France, particularly in the devastated area, and at a time when a change to new customs is easier than ordinarily. With central storage plants, there should be established a system of official inspection and classification as to quality of produce received, with receipts issued in such a way as to be usable as collateral or pledge at the banks.

Fertilizers and soil disinfectants, especially potash salts from Alsace, should be quickly industrialized for export, and be exploited.

The reconstitution of French agricultural methods, in so far as this can be undertaken to advantage, should be decided on as quickly as possible during the present period of general commercial readjustments. Great aid would follow the wide publicity through Government channels of details of recommended changes in procedures and the reasons for their adoption.

Should co-operation be desired from America along any lines, it is best that each specific case be dealt with separately. American capital in substantial sums is not likely to come to the aid of French agriculture, except under conditions satisfactory to American bankers and doubtless on the recommendation of American engineers.

Commercial organizations to exploit American methods in France should give due consideration to using, for a time at least, American supervision, so as to teach the details to French associates.

In France, as in America and other countries, hygienic conditions among the farmers are not as favorable as in the cities. This is due to ignoring well known public health teachings in relation both to personal hygiene and community sanitation. It can be corrected only by persistent and systematic campaigns of publicity through the aid of practicing physicians, health officers of communes, school teachers, and influential citizens, and particularly of the local press, all of whom can advantageously be guided at district conventions conducted by the National Health Council. It is well to remember that the transmission of disease by flies may be a much more serious factor in the future than before the war which has brought millions of foreign troops to France.

Rural welfare movements to increase the comforts of farm life are well worth while, and publicity campaigns to that end should follow similar lines to those suggested for rural hygiene, all with the view of securing popular and effective local leadership for moulding public opinion.

Committee on Technical Education.

This Committee held three meetings—on December 21st and 23d, 1918, and on January 15th, 1919. Views were exchanged with reference to a variety of subjects and, in general, the French engineers and the American delegates were in agreement.

The French system of education is quite different from the American system. All schools, both public and private, in France, are under the control of the Ministry of Public Instruction, and under the supervision of a council and a corps of inspectors. The so-called "primary" schools take the children up to the age of 13. Instruction is obligatory for all children between the ages of 6 and 13. The so-called "primary superior" schools take children from 13 to 16. The so-called "secondary schools", attendance of which is not obligatory, take children from the ages of 13 to 20. This instruction, general in character, is followed by the strictly professional education in the polytechnic schools and universities.

Graduates from the engineering schools in France are on the average older than in the United States. They have received admirable theoretical and general instruction, but probably they have received less technical and practical education than in the schools in the United States.

It was the opinion of some of the French engineers that the technical education was too general and theoretical, and that the course was completed too late. In this, the American engineers held the same opinion.

The opinion was also expressed by the French engineers that the teaching of general studies and sciences in the technical schools should be practical and directed to the needs of the engineer. The instruction in mathematics should not be abstract and theoretic, but practical and concrete. The same is true with regard to instruction in languages and other studies. This tendency is the same that is observable in many of the schools of the United States, and they were heartily approved by the American representatives.

The French are much concerned in the problem of training apprentices. The trades and technical occupations should, as a result of the war, attract an increasing number of young men who need manual training and practical instruction in the shop in the various trades. The object should be to give such vocational instruction as would select the right young men for the occupations for which they are naturally fitted.

Apparently, the French are doing more in training apprentices in public schools than we are doing in the United States.

The French engineers fully realize that after the war the problem will be to bring about as large a production as possible, accompanied by increased efficiency. The subject of efficiency in industrial establishments is occupying a great deal of attention in France. The works of the late Frederick W. Taylor are widely quoted and used. Instruction is given in some of the schools in reference to this subject.

Technical instruction in France is confined to the secondary and superior schools. As for the secondary schools, where the students range from about 13 to about 20, the French engineers express the opinion that the instruction should be more specialized, though not too much so, and that the attention of students should be directed toward industrial questions, with the object of provoking early the recognition of industrial pursuits and directing into such pursuits such young men as are qualified.

It was considered necessary to introduce some manual training into such schools.

There was much discussion with reference to the proper location of technical schools. In France, such schools are generally located in the closely built portions of the city, and little attention is paid to physical exercise, play, games, or athletics. The engineering schools also are located in the same manner, and their quarters are frequently so cramped that extension is impossible. The American engineers urged the importance of having technical schools and universities located in or near the suburbs of the cities, where extension was possible and yet where contact with industrial establishments could still be had. The French engineers seem to appreciate the importance of this matter.

There was considerable discussion with reference to methods of instruction, number of students in classes, the necessity of rigorous

discipline rather than freedom of students, the benefits of conferences with professional engineers, etc.

One of the most important points discussed had reference to the exchange of students and teachers between the two countries. The American delegates pointed out the fact that in the past the French schools had not offered as many attractions to American students as the German universities. Many of the most eminent scientists in America have studied for a longer or shorter time at German universities. Such men are found in all branches of pure science, in law, medicine, history, economics, and engineering. Probably there have been fewer in engineering than in pure science, because, although pure science is the same everywhere, the method of application may differ greatly in different countries, and the methods in use in one country may not be applicable in another. Nevertheless, there have been many American students at the technical schools of Germany and Switzerland, and comparatively few at the schools of France. The American delegates expressed the hope that in the future these things will be changed, and that young Americans who desire to go to Europe to study will be attracted to France. If this is to come about, however, the French must not be extremely rigid on small points, nor must they insist on precise equivalents or require rigid examinations.

The benefit that a young man gets from study abroad is often more from traveling, the knowledge of a foreign language and foreign people, general broadening of his point of view and sympathy, than from the precise details of knowledge.

It is in the highest degree desirable that young men from any country desiring to study in another, should be received hospitably, and that they be allowed to get what they can as long as they attend to their business. A young man who goes to a foreign country, well recommended from the schools in his own country, and with credentials which show him to be earnest and serious in his intentions, should be given free opportunity unhampered by precise requirements. A broad system of equivalents in studies should be recognized. It should be easy to enter a foreign institution, but once having entered, the student who is found neglecting his work or manifestly wasting his time, should not be allowed to continue.

L'Ecole Centrale des Arts et Manufactures, in Paris, was visited by the Delegation at the invitation of its President. Its class-rooms and laboratories, as well as the work of its students, were open to inspection. This school has always admitted Americans as well as other foreigners to its examinations, and those who passed such examinations with sufficient credit were entitled to admission just the same as French boys. This method, however, has not served to attract many Americans, for reasons already stated. A modification of the method is in con-

templation, by which a system of equivalents will be used, and it is hoped that this system may be adopted.

The American delegation assured the French engineers that the American universities would welcome any Frenchmen who desire to study in America and would offer them every opportunity to profit by such study, and that they believed that these universities would be reasonable and liberal in accepting as a preparation the work done in France. These views were received with approval by the French engineers.

It should be added that the French contemplate spending considerable sums of money in improving their technical schools, which, at the present time, as far as we are informed, do not offer the material advantages in equipment, laboratories, etc., that are offered by the best American schools. Many of the French professors, however, are most eminent; and the courses of study under some of these, even with less perfect equipment than we have at home, might well be of benefit to young Americans who desire some foreign study in completing their own professional courses.

The interchange of teachers or assistants for short periods was discussed, and the opinion was expressed that it ought to be encouraged if possible.

Altogether, the French and the American engineers were not in disagreement with regard to any of the essential points discussed with reference to technical education. It is to be hoped that the continuance of these discussions may lead to increasing co-operation between the two countries and increasing knowledge of each other.

At the last formal meeting of the Congress, President Millerand suggested the desirability of forming a permanent International Franco-American Engineering Committee, so that the engineers of both countries could keep in touch with each other, and by means of which specific problems could be discussed and co-operation promoted between the two countries. A formal vote was passed approving the formation of such a permanent committee. The members of the Delegation were asked if they would serve as the American members of such a committee. They replied that they could not accept this invitation, as they had not been appointed permanently by the Societies they represented, and that they would report to these Societies on their return to America and ask them to appoint members of a permanent committee. The Delegation was then asked if they would serve temporarily as the members of such a permanent committee, and this they consented to do.

The French members of such permanent committee were appointed, and consisted of the Presidents of the Sections of the Congress, and the General Secretary, all these gentlemen being the men with whom

the members of the Delegation had discussed the various problems which have been referred to in this report.

Immediately on its return to America, the Delegation made a report to the four Societies, reciting the action of the Congress with reference to the appointment of the committee, and asking the Societies to take action. This report is added as Appendix III to this final report.

This completes the statement of the discussions of the various topics presented to the Delegation.

It should be added that the Delegation was entertained most hospitably by the French Congress and by the French engineers, and that everything possible was done to make its visit pleasant and profitable. The members of the Delegation desire to express their appreciation of the many courtesies and hospitalities which were tendered to them.

Respectfully submitted by the Delegation,

GEORGE F. SWAIN, *Chairman**
JAMES F. CASE,
NELSON P. LEWIS,
GEORGE W. TILLSON,
GEORGE W. FULLER,
A. M. HUNT,
CHARLES T. MAIN,
L. B. STILLWELL,
E. G. SPILSBURY.

* As Maj. Case decided to remain in Europe, Professor Swain became Acting Chairman of the Committee.

APPENDIX I

PRELIMINAY REPORT OF THE AMERICAN DELEGATION OF ENGINEERS.

TO THE CONRÈS GÉNÉRAL DU GÉNIE CIVIL,
19 rue Blanche, Paris, France.

GENTLEMEN:—The Delegation of American Engineers which has visited France at your invitation, desire, before leaving for America, to submit to you a brief report, covering the questions which have been discussed with you and giving such of its conclusions and recommendations as it is able at the present time to formulate.

The Delegation was divided into six committees, corresponding essentially to your own committees. These committees were the following:

1.—*Committee on Commercial Ports.*—Messrs. James F. Case, Chairman, Charles T. Main, E. G. Spilsbury, A. M. Hunt.

2.—*Committee on Water Power.*—Messrs. Lewis B. Stillwell, Chairman, A. M. Hunt, Charles T. Main, George F. Swain.

3.—*Committee on Navigable Waterways.*—Messrs. George F. Swain, Chairman, James F. Case, Charles T. Main, E. Gybbon Spilsbury.

4.—*Committee on Roads.*—Messrs. George W. Tillson, Chairman, Nelson P. Lewis.

5.—*Committee on Technical Education.*—Messrs. George F. Swain, Chairman, Charles T. Main, Lewis B. Stillwell, E. Gybbon Spilsbury.

6.—*Committee on Agricultural Development.*—Messrs. George W. Fuller, Chairman, James F. Case, Nelson P. Lewis, George W. Tillson.

The Committee on Commercial Ports and the Committee on Navigable Waterways, however, were not separated in the conferences; so that, in reality, there were five committees.

The Committees have read so far as practicable the papers presented to the Congrès last March, have discussed the various resolutions there adopted, and have considered such other questions as were presented to them. The Secretary of the Congrès, M. E. Barbet, has prepared and submitted to you a careful and elaborate report of the proceedings in which we have taken part. At the present time, we cannot do more than refer to the conclusions and the resolutions passed by the Congrès in March, and to make such comments on them as seem proper to us after having listened to the discussions and visited the localities to which we have been taken.

COMMITTEE ON PORTS AND INLAND WATERWAYS.

The Committee has read the papers of the Congress held in March relating to the questions of Ports and Navigable Waterways, and has considered the resolutions passed by the Congress. Taking up the papers in order, and the resolutions contained therein, the Committee has the following remarks to make:

I.—Paper by M. Jean Hersent (Volume 1, Page 107), on "The Utilization of Commercial Ports".—Resolutions on Pages 117 and 118.—

"1. Considerant la necessité de construire vite et economiquement les ouvrages qui dôivent repondre a l'accroissement du tonnage de la marine marchande, le Congrès emet le vœu:

"(*a*) Que pour les ouvrages importants il soit etabli et mis au concours un programme de previsions correspondant aux besoins de l'avenir, et que les efforts essentiels soient repartis principalement sur quelques grands ports."

The Committee approves this resolution. It is very important to establish a plan of operation which can be carried out as rapidly as opportunity and funds permit, and which will result in the greatest immediate benefit to the large ports. The programme should be planned in such a way that resources will not be scattered or the attainment of immediate results unduly delayed.

Experience in the United States has demonstrated that execution by contract after competitive bidding is an economical and desirable method of carrying out such work.

"(*b*) Qu'il soit prevu des ouvrages de construction economique et rapide tels que des estacades, piers ou wharfs, ducs d'Albe a l'exclusion de quais pleins, partout ou les conditions techniques le permettront."

The Committee agrees with this recommendation, especially in view of the fact that one of the results of the war will be the changing of trade routes, and it will be necessary for France to act quickly in providing facilities for handling overseas traffic.

"2. Considerant que les plans des bassins doivent prevoir l'avenir, le Congres emet le vœu que soit adopté et developpé le systeme usité en Amerique de wharfs paralleles qui, en permettant l'allongement des ports, facilite aussi l'installation des voies ferrees de service."

We entirely agree with this recommendation. Experience in America has shown the great advantage of railroad tracks along the wharfs parallel to the ships' berths, permitting the rapid handling of cargo from the ships to the cars, or *vice versa*.

"3. Considerant que le developpement des ouvrages interieurs de nos ports demande la creation de rades-abris, le Congres emet le vœu que des rades-abris soient envisagees et etudiees aux ports du Havre."

We agree with the recommendation. Experience in the United States has shown the advantage of safe anchorage space in the roadsteads, away from the wharves, where overside stream delivery or receipt of cargo may be made to or from barges, lighters, or other means of conveyance. This will also relieve the congestion at the docks.

"4. Considerant l'importance jouee par l'outillage dans nos ports, le Congres emet le vœu l'étude de l'outillage mécanique soit faite en même temps que celles des ouvrages fixes et sur un plan d'ensemble.

"Que l'on applique les methodes nouvelles en modernisant l'outillage, en adaptant les apparaeils de levage et de manutention aux systemes d'accostage.

"Que l'usage de l'outillage soit mis a la disposition de toutes les marchandises susceptibles d'en profiter.

"Qu'il soit prevu des terres-pleins spacieux, hangars, silos, elevateurs, magasins pourvus de tous les perfectionnements modernes.

"Enfin que les raccordements de voies de quais avec les lignes des gares de depart direct fassent l'objet d'une etude attentive afin d'eviter les encombrements et l'amoncellement des marchandises dans les ports de commerce."

The Committee entirely approves this recommendation. The rapid handling of freight, permitting quick departure of vessels, is a most important factor in the economy of ocean transport.

Furthermore, the Committee thinks that there is scarcely anything more important than close connections between railroad tracks and the wharves.

"5. Considerant l'augmentation croissante des dimensions des navires et les difficultés qu'ils rencontrent pour entrer de jour et de nuit dans les bassins a flot.

"Considerant l'insuffisance des bassins de radoub actuels pour la reparation ou l'entretien des navires.

"Le Congres emet le vœu:

"1°—Developper les bassins a maree en eau profonde.

"2°—Developper la construction des grands bassins de radoub a double entree quand les dispositions du port le permettent."

The Committee believes that the Congress would do well to study the methods in use in America for loading and unloading facilities alongside the wharves, even where there is a considerable range of tide, without the use of enclosed basins entered through locks. Experience in our ports, and at Panama, has demonstrated that locks are not necessary, even where the range of tide is very considerable. If the docks are equipped with proper mechanical devices for loading and unloading, it makes little difference whether the vessel stands high or low above the dock. The Committee will not attempt to fix the limit of tide above

which locks should be used, but, at some American ports, they have not been found necessary with a range of tide of 6 or 7 m.

The proper facilities for the repair of vessels should be provided at every large port.

Resolutions on Pages 124 and 125.—

"1. Considerant que le regime actuel de nos ports doit etre en rapport avec les necessités economiques du pays et que le developpement de ces ports ainsi que leur meilleure exploitation sont devenus indispensables;

"Considerant que l'avenir de nos ports de commerce et les moyens d'entirer avantageusement parti dependent uniquement des dicisions a prendre par l'Etat;

"Le Congres emet le vœu que l'Etat, avant d'engager de nouvelles et importantes depenses, ait recours, pour la construction et l'exploitation de nos ports de commerce: soit au regime d'une Administration autonome concue sur des bases pratiques et industrielles, soit au systeme des concessions avec ou sans garantie d'interet."

The Committee approves this recommendation.

"2. Considerant que la loi sur l'automonie des ports votee en 1912 a donne lieu a un reglement d'Administration qui ne tient pas suffisamment compte des desiderata exprimes par les Chambres de commerce et qu'en consequence l'application s'en est trouvee empechee;

"Le Congres emet le vœu:

"Que la loi de 1912 soit maintenue et le reglement paru en 1916 modifié et que dans la composition du Conseil de direction, il soit reservé une place plus importante aux representants competents de l'industrie, du commerce et de la marine non seulement de la localité, mais de la region interessee au developpement du port."

The Committee is not informed in reference to the law of 1912 or the regulation of 1916, but it believes that it is very important that competent representatives of the industries should have a voice in the decision of matters relating to the development of ports—subject, of course, to the power of decision of some competent public authority.

"3. Considerant que, dans les ports ou le regime de l'autonomie ne serait pas appliqué, la dispersion des chapitres de recettes et depenses entre plusieurs services ou organismes: services des travaux, de l'outillage, des chemins de fer, etc., ne permet pas d'avoir une vue d'ensemble aussi bien sur l'importance du port que sur les sacrifices consentis pour son developpement, son entretien et son exploitation.

"Considerant, d'autre part, que de l'etat actuel des choses il resulte que les recettes et produits sont consideres par l'Etat comme formant une masse a repartir ensuite indifferemment sur tous les ports, en sorte que les ports deficitiaires vivent aux depens

des ports beneficiaires, alors que ceux-ci sont parcimonieusement pourvus des installations qu'appellerait precisement le developpement de leur traffic.

"Le Congres emet le vœu;

"Que chaque port centralise la comptabilite de tous les services, de maniere a faire établir annuellement un bilan de recettes et depenses afferentes a chaque port, en meme temps qu'une bonne statistique."

The Committee approves this recommendation. The financial and other statistics relating to each port should be kept separate, in order that improvements may be made in such a manner as to be economical, efficient, and to meet the needs, not only of the ports, but of the country as a whole.

"4. Considerant que la creation de zones franches ou les marchandises pourraient etre entreposees en franchise, melangees, ameliorees, transformees, mais non usinees, aurait pour consequence d'accroitre le mouvement maritime et l'activité industrielle qui en derive;

"Le Congres emet le vœu qu'il y aurait lieu, dans l'interet du commerce general, d'autoriser, dans l'enceinte douaniere de nos grands ports, l'essai de zones speciales, appelees *zones franches*, dans lesquelles les marchandises pourraient etre entreposees en franchise, melangees, ameliorees, transformees, mais non usinees, et sans formalites speciales douanieres dans l'interieur de la zone."

The Committee approves this recommendation.

II.—Paper by M. Paul Govare (Volume 10, Page 106), on "Free Ports".—This report deals with the question of free ports. It does not, however, contain any conclusions or resolutions adopted by the Congress. It is, therefore, not necessary for the Committee to remark on it, except to say that the experience of Hamburg and other free ports seems to demonstrate the desirability of at least making an experiment in this direction.

III.—At the meetings of the Committee we were asked our opinion with reference to the proper dimensions of locks, and we were unanimously of the opinion that it would not be wise to provide for locks of greater dimensions than those used for the Panama Canal. We, therefore, agree that these dimensions, *viz.*, length, 1 000 ft., width, 100 ft., and depth, 40 ft., should be the greatest dimensions of vessels for which it would be necessary to provide.

We were also asked with reference to economical methods of handling cargoes at docks, and with reference to dry docks and floating docks. We promised to send to the Congress, after our return to America, a report dealing with these subjects.

We were also asked with reference to methods of administration of ports—whether by the State, the city, the railroad companies, or the

steamship companies. We promised to submit a report on this question also.

These reports will also deal with the kinds of dredges used in the United States, their capacity, the depth of water in which they can operate, and other similar questions.

Committee on Water Power.

Report by M. Verdin.—Page 44 of the Proceedings of Section I.— The conclusions of the Congress, with our remarks, are as follows:

A.—"Que les pouvoirs publics discutent et promulguent, dans un delai aussi court que possible, le projet de loi deposé par le Gouvernement sur le bureau de la Chambre des Deputes dans sa seance du 20 Juillet 1917."

In view of the fact that the Commission is not fully informed regarding the law referred to, and the circumstances affecting it, we do not feel that we can comment on this resolution.

B.—"Que l'administration continue et acheve l'etude des resources hydrauliques de la France."

The Committee strongly endorses this conclusion. Attention is called to the fact that if partial development of the power of a stream is made before an exhaustive study of its entire possibilities has been completed, it may be found later that such partial development has led to a situation preventing the most economical utilization of the entire stream.

C.—"Que les encouragements de l'Etat soient assures a ces entreprises, tant par des subventions financieres, quand il y aura lieu, que par un regime d'associations syndicales permettant aux industries de recuperer partiellement les sommes qu'elles auront investies dans les travaux de regulation ou d'amenagement des cours d'eau."

The Committee is convinced that no project should be undertaken unless it can be demonstrated with reasonable certainty to be economically justified and self-sustaining, all elements of the problem being considered. The Government should undoubtedly encourage those projects which can be so justified, and, if it can render financial aid, it is desirable that such aid should be extended as a temporary measure, or in view of demonstrable collateral advantages.

D.—"Que la fabrication des machines hydrauliques et electriques en France soit developpee, par l'initiative des particuliers et avec l'appui des pouvoirs publics."

The Commission is of the opinion that France should encourage the manufacture of all machinery required for hydro-electric development within her own borders, but if the development of hydro-electric power

in France would be unduly retarded by waiting for the home production of such machinery, it would be wise to make such purchases as may be necessary abroad, pending the time when French factories are able to supply French requirements. If the exclusive use of French material is insisted on, under all circumstances, it may result in a loss to the country rather than a gain.

E.—"Que les autorisations relatives a la creation des reseaux electriques soient subordonnees a l'obligation, pour les concessionnaires, d'adopter des types de courant permettant le raccordement facile avec les reseaux voisins preexistants."

The Commission emphatically endorses this conclusion, and expresses the opinion that it should be made more definite and inclusive. It is of the greatest importance that standard characteristics for current from all plants, for which concessions are granted in the future, should be promptly established and rigidly enforced, having in view the fact that France is of such an area and form that it can be covered ultimately by a unified system of power distribution fed from many different sources. This would be of great economic value, because of its resultant equalizing of non-synchronous seasonal variations of stream flow in different localities, and because it will permit the most effective and economical co-operation of steam and water power in supplying electric power for all purposes throughout France.

Report by M. Henri Defer.—Page 106 of the Proceedings of Section II.—The resolutions adopted, with our comments, are as follows:

A.—"Qu'une entente benevole s'etablisse entre les exploitants des forces et des beautes naturelles du territoire national egalement interesses a l'utilization des unes et de la conservation des autres et, qu'a l'exemple du Comité des forces hydrauliques et du Touring-Club de France, l'institution de Commissions mixtes d'etude des projets de derivation de cours d'eaux et de constructions d'usines soit generalisee entre les divers groupements interesses."

The Commission endorses this recommendation, and is of the opinion that no time should be lost in instituting the mixed commissions referred to, and in imposing on them the duty of making definite decisions with such promptness that the utilization of water powers which may be found economically available, shall not be unduly delayed.

B.—"Qu'il soit procede a une etude d'ensemble pour l'amenagement en montagne sur des points bien choisis de barages et reservoirs propres a regulariser le debit des rivieres et a rendre ainsi possible une meilleure et plus complete utilization des forces hydrauliques du pays, tout en assurant la sauvegarde de ses beautes naturelles."

The Commission endorses this recommendation.

Report by M. Jean Rey.—Pages 31 and 32 of the Proceedings of Section VI.—The conclusions, with our comments, are as follows:

A.—"Le Congres, vu la necessité imperieuse de doter notre Industrie d'une loi generale reglant l'amenagement de nos forces hydro-electriques, demande aux Pouvoirs publics de faire voter d'urgence le projet de loi deposé au Parlement en juillet 1917, et elaboré par une Commission extra-parlementaire, relatif a l'utilisation des forces hydrauliques.

"Le Congres rappelle au Parlement que cette loi si importante attend, depuis plus de 20 ans, le bon plaisir de nos elus, et que, pour cette branche de notre activité nationale comme pour toutes les autres, la routine et les lenteurs de nos legislateurs entrainent les consequences les plus dommageables pour la prosperité de notre industrie et de nos finances."

The Commission is not informed in regard to the provisions of the proposed law, and, therefore, does not comment on it. We are strongly impressed, however, with the fact that France is paying annually very large sums for imported coal, and that it is of the utmost importance for the prosperity of the country that the development of hydraulic power, wherever economically practicable, should be encouraged and promoted as rapidly as possible.

B.—"Le Congres demande aux pouvoirs publics d'accorder aux Etablissements de credit hypothecaires, les autorisations necessaires pour permettre le pret sur hypotheque pour les chutes hydrauliques, cette modification etant accompagnee des conventions necessaires fixant les bases et les modalites de ce genre nouveau d'hypotheque."

If the water powers of France are to be developed by private enterprise, it is the opinion of the Commission, based on experience in America, that the plan contemplated by this resolution, or its equivalent in some other form, is essential.

C.—"Le Congres, constatant l'interet national qui s'attache a la jonction et a l'uniformisation de nos reseaux de distribution d'electricite, demande aux Pouvoirs publics de prescrire, pour les transports nouveaux d'energie electrique, l'emploi du courant triphase a la frequence de 50 periodes par seconde, et dans le cas d'applications speciales necessitant une frequence moindre, celle de 25 periodes."

The Commission is of the opinion that a frequency of 50 periods per sec. should be prescribed generally for local distribution of electricity in France, but calls attention to the fact that if the great undeveloped power resources of France are ultimately to be utilized to the best advantage, it will be necessary to connect, by circuits operating at very high potential, sources of power separated by great distances,

as, for example, the Upper Rhône and the coal fields in Northern France. For transmission over such distances, the frequency of 25 cycles affords material advantages, particularly as regards regulation of potential. It would seem, therefore, that for installations which probably will be thus connected, the frequency of 25 cycles per sec. should be considered very carefully.

D.—"Le Congres recommande aux concessionnaires de transport d'energie electrique de limiter, pour les nouvelles installations, le choix du voltage a l'un des taux qui seront indiques par le Ministere des Travaux Publics, et, dans l'avenir, lorsqu'il sera question de remanier un reseau existant en modifiant son voltage, de s'arreter a l'une des valeurs ainsi determinees."

The Commission strongly endorses this recommendation. Standardization of electric apparatus is essential to large production and low cost.

E.—"Le Congres signale aux exploitants des distributions d'electricite l'interet capital qu'il y a, des maintenant, a etudier et a realiser toutes les dispositions permettant l'entr'aide des reseaux les uns par les autres."

The Commission endorses this recommendation.

F.—"Le Congres, constatant l'interet economique qu'il y a à diminuer l'importation du cuivre consommé par notre industrie electrique, recommande aux concessionnaires de reseaux d'electricité l'emploi de l'aluminium, metal que la France peut produire en quantité illimitee."

The Commission concurs in this recommendation as regards electric conductors not covered by continuous insulation. Other things being equal, the use of aluminium is obviously advisable.

Report by M. de France.—Pages 61 and 62 of the Proceedings of Section VI.—The resolutions proposed, and our comments on them, are as follows:

"Le Congres, considerant que l'amelioration de nos moyens de transport est une condition essentielle a la prosperite economique du pays, exprime les voeux suivants:

"1.—Que les Compagnies constituent une Commission d'etudes pour l'application immediate de la traction electrique a tous les cas ou les experiences anterieures ont prouve que cette application etait avantageuse: lignes de banlieue et de grande banlieue jusqu'a 100 kilometres, lignes de grand trafic a grande periodicite, lignes de montagnes et principalement dans les regions ou les installations hydro-electriques fourniront de l'energie a prix reduit;

"2.—Que les Compagnies adoptent, le plus rapidement possible, dans toutes leurs gares, des appareils electriques de manutention, de signalisation, d'aiguillage, et, dans toutes les gares de triage, de bifurcation et d'embranchement, des locomotives et appareils electriques de manoeuvre;

"3.—Que les conventions de 1883 soient modifiees et que la duree des concessions soit prolongee avec relevement temporaire des tarifs, afin de permettre aux Compagnies de Chemins de fer, sans recourir au credit de l'Etat, de realiser l'electrification successive des diverses lignes de leurs reseaux;

"4.—Que le Comite d'electricite procede, des maintenant, a la revision des reglements techniques pour l'application de la loi du 15 juin, 1906, les mette en harmonie avec les nouvelles decouvertes de la science, les resultats pratiques de l'experience, reforme notamment l'arrete technique du 21 mars, 1911, dans un sens plus large et plus conforme a la technique de distribution pour les voies ferrees."

The Committee, so far as it can express itself, approves of these resolutions, although it is not informed with reference to the conventions of 1883, or the law of June 15th, 1906, or the *arrete technique*. It is clear, however, that previous regulations should be modified in such a manner as to conform to new discoveries or improvements in the application of electricity, and that the railroad companies should be encouraged in every legitimate way in the electrification of their lines, if it can be accomplished economically.

Report by M. Paul Toulon.—Page 11 of the Proceedings of Section X, 3d Sub-Section.—

A.—"Que les Pouvoirs publics favorisent le plus possible les installations nouvelles d'usines hydrauliques de production d'electricite et la distribution du courant aux plus grandes distances compatibles avec les progres techniques acquis actuellement, d'une part, et avec les frais d'etablissement acceptables, d'autre part."

The Committee approves this statement.

B.—"Qu'un programme d'ouvrages de distribution dont l'etablissement dans les premieres annees d'apres-guerre apparait des a present comme necessaire, soit mis a l'etude aussitot que possible et poursuivi suivant la methode heureusement employee pour la reconstitution des reseaux electriques des regions envahies."

The Committee entirely approves the recommendation that a programme be studied as soon as possible, but it does not know what method was used for the reconstitution of the invaded regions, and, therefore, can express no opinion regarding it.

C.—"Que les usines thermiques ou hydrauliques a construire en execution de ce programme soient prevues en tenant compte des reseaux existants et des conditions ou la production du courant sera le plus economique, la nature et la frequence du courant devant etre notamment arretees de maniere a permettre aux usines de s'entr'aider."

This recommendation appears to have been substantially covered by preceding demands of the Congress, which we have endorsed.

D.—"Que, simultanement, afin d'en permettre la realisation rapide, une etude soit faite des dispositions legislatives ou administratives a envisager pour faciliter aux entreprises de distribution concessionnaires de l'Etat, des departements ou des communes, l'obtention des capitaux necessaires a leurs extensions, en generalisant par exemple le systeme des avances faites par les communes, avec le concours du Credit Foncier, des caisses de credit agricole, etc.

E.—"Que tous les Pouvoirs publics examinent dans un esprit d'equite les demandes de relevements temporaires des tarifs que de nombreux distributeurs d'electricite se sont trouves dans l'obligation d'adresser aux autorites dont ils dependent.

F.—"Que pour faciliter le groupement des entreprises de distribution, dont les capitaux et les reserves sont generalement immobilises en totalite dans leurs reseaux, tous les actes de fusion de societies ou de concessions soient exempts des droits d'enregistrement en ce qui concerne la mutation afferente aux installations destinees a faire retour en fin de concession aux autorites concedantes.

G.—"Que, dans le mêne ordre d'idées, des mesures soient prises par l'administration superieure, pour qu'en cas de fusion d'entreprises de distribution, les transferts de concessions communales puissent etre soustraites aux exigences, parfois excessives, des autorites concedantes.

The foregoing paragraphs, D, E, F, and G, are concerned with legal and financial questions regarding which the present information of the Committee is not sufficient to justify an expression of opinion, beyond the statement that we regard it as obvious that effective measures should be taken as promptly as possible to facilitate the extension of existing electric installations and the construction of new ones in all parts of France where such extension or new construction can be justified by conditions of present demand for power, or by conditions which assure the development of an adequate demand when power is made available.

General Conclusions.—The general conclusions of the Committee may be summarized briefly, as follows:

France has within her borders, in three rather widely separated regions, water-power possibilities which are probably sufficient, if developed and utilized, to obviate the necessity now existing of importing coal for power purposes.

The Governmental authorities, in the interest of the nation, should take all steps possible, including the early passage of enabling laws, to encourage and stimulate the development and utilization of these natural resources. The broad national aspect of the problem should at all times be given full consideration.

The ultimate goal should be that of a unified and inter-connected system, in which the different groups of plants in the several regions of power development become elements of such a nation-wide system.

The importance and desirability of such a plan is emphasized by the study of the seasonal characteristics of the flow of the streams in the different regions. We are informed that the low-water flows in these several regions do not occur simultaneously. This being so, combined operation will make it possible to utilize a greater quantity of continuous power than can be utilized if the various groups of plants are operated independently. No insurmountable technical difficulties stand in the way of the operation of such a unified system. There exist in the United States power-distributing systems covering areas and distances comparable to those involved in a unified system for France. Although the Committee is not in possession of the data for an exact study of the cost and results of inter-connecting the several regions, a general consideration of the situation leads to the opinion that it would be amply justified.

In connection with such a system, consideration should be given to the possibility of supplementing the water power by steam power, perhaps, in some cases, by burning the lower grades of coal at the mines.

Such steam plants should be connected to the general distributing system, and operated in such a way as to supplement the varying quantity of power which can be derived from the hydraulic sources. The concentration of electric power production by steam in a small number of large modern plants will result in a great economy of coal, as compared to the quantity required to produce equivalent power in a large number of small steam plants; and, at high potential, such as is now in successful use in America, electric energy can be transmitted for much less than the cost of transporting the coal required to produce the same amount of energy. The use of auxiliary steam power developed in large plants properly inter-connected with hydro-electric plants can be utilized advantageously in supplementing power from the latter at certain seasons of the year.

The foregoing considerations emphasize the importance of standardization, and of limitations which should be placed on permitted frequencies and voltages.

Action on the part of individual companies to bring about the realization of such an ideal system of national power supply, as has been outlined, will probably not come unless the public authorities initiate it, or, by permissive and favorable laws, make such action both easy and profitable to them. In our opinion, the accruing advantages to the nation are sufficient to justify a very thorough study and analysis of the problem in all its technical and economic aspects.

COMMITTEE ON NAVIGABLE WATERWAYS.

The reports of the Congress contain two papers on this subject, and they will be briefly referred to. They are the report by M. le Colonel Espitallier, on the "Reseau de la Navigation Interieure en France," on page 50, of the Proceeedings of Section II, and the report by M. le Docteur Ed. Imbeaux, on "L'Interet de la Creation d'un Reseau de Grande Navigation Interieure en France: Principales Conditions de l'Etablissement et de l'Exploitation de ce Reseau," on page 66, of the Proceedings of Section II.

These two papers are very interesting. They give descriptions of the system of interior navigation in France, and the future requirements which the authors consider necessary. The resolutions deal chiefly with the special projects which have been made, such, for instance, as the improvement of the Seine, the Rhône, and the Loire Rivers, and the systems of internal navigation in the northeast and the southwest. The Committee has not had the opportunity to study these projects in detail, and, therefore, it will not comment specifically on the separate resolutions. It will, however, state its views on the question of interior navigation, as follows:

By internal navigation is meant the provision of waterways for the use of barges or small boats, by: 1. The construction of canals; 2. Making the rivers navigable by locks, dams, canals, and other works.

Historical.—The development of transportation by internal navigation dates back to a period before the construction of railways, beginning with the construction of the early canals in England. At that time, it was undoubtedly wise and desirable that canals should be built and rivers improved for navigation, because there were no other means of transportation except by vehicles on roads, and it was obvious that a large tonnage could be handled much better on navigable waterways.

The construction of the English canals was followed by the construction of canals in other countries, such as the United States, France, Germany, Belgium, and The Netherlands. In some of these countries, extensive works of this kind were undertaken, and have been continued to the present day.

Experience in the United States.—In the United States, the experience with works of inland navigation has been disastrous. Almost all the early canals have been abandoned, and several of the States have lost all the money invested in them, and have been obliged to default on the interest on the debt created for their construction.

In some special localities, canals have proved of use, as, for instance, the canals at Sault Ste. Marie, between Lake Michigan and Lake Superior, carrying the large vessels of deep draft which ply on the Great Lakes.

With this exception, practically the only canal that has not been abandoned in the United States is the Erie Canal in New York State. After the construction of railroads, the traffic of this canal declined so rapidly that, in 1883, all canal tolls were abolished. The abolishment of tolls, however, did not check the decline of traffic, and although the traffic on the railroads was increasing by leaps and bounds, the traffic on the canal diminished to almost nothing.

In 1903, the sum of $101 000 000 was appropriated for enlarging the Erie Canal to a depth of 12 ft., sufficient for barges having a capacity of 1 599 or 1 699 tons. The sum appropriated did not provide for terminals, and the work has not been completed. The cost of the entire work, including terminals, will probably be considerably more than $130 000 000. The original appropriation of $101 000 000 will exceed $294 000 per mile. This work has not yet been completed, and many of our best engineers consider that it will not be successful and that the expenditure will prove to have been entirely wasted. In any case, it seems certain that a double-track railroad could have been constructed between the same points for much less, and with a much greater capacity than the canal.

The experience in the United States with inland waterways, therefore, has been entirely unfavorable, and has occasioned a careful study of the economics of the subject.

There are cases, of course, in which the construction of canals and the improvement of rivers for navigation are justified. In Europe, the conditions are much more favorable than in the United States, because the rivers generally have flatter slopes and there is not so much interference with traffic in the winter and by floods.

We are informed that, in France, the Government has assumed the payment of interest on all works of internal navigation and also the expenses of maintenance, so that the only charges for transportation are those paid to the boatmen. Nevertheless, in determining the economics of water transportation, these items should be included for, contrary to customary belief, such an expense paid by the State is, in fact, paid by the people just as much as if included in the actual charge for transportation.

There is no sentiment about transportation. The question is purely an economic one, and should be considered on economic grounds only. If the conditions in any special case are such that inland navigation can be provided, which will carry traffic cheaper than a railroad, and if the traffic is available and will produce a fair return on the investment, then the project is economically sound; otherwise it is not, and should not be attempted.

We have been surprised that nowhere in the papers which we have read, or in the projects which have been explained to us, has there been

any economic study of these questions, but only a technical study. We have been surprised, also, that, in the proceedings of the Congress, there has been so little attention given to the subject of railroads—although this is undoubtedly the most important agency in the development of national prosperity.

We are strongly impressed, as a result of our visit to France, with the necessity and desirability of the development of three great factors in national prosperity, *viz.,* the ports, the railroads, and the water powers. If France is to have the trade which it deserves, it must develop its ports so that it can handle that trade.

Again, the great lack of France is coal, of which it has not enough to supply its needs. Moreover, every pound of coal that is burned is lost forever, and will never be available for future generations. Coal, therefore, has an economical value in addition to its material value in dollars and cents, and it is extremely important that all reasonable means should be taken to conserve the supplies of coal, so that the future generations will be assured the heritage which properly belongs to them.

On the other hand, France has large undeveloped water powers, some or many of which, especially in view of the shortage of coal and its economical value, may be economically developed.

We have been informed that many water-power projects have been delayed for years, on account of the desire to await the development of navigation. We believe that the two interests, while they have much in common, are also, in a sense, antagonistic. The four purposes of control of a river are: For the development of power, for irrigation and the supply of cities, for the improvement of navigation, and for the regulation of floods. These four purposes are, in some ways, antagonistic. If a river is used largely for navigation, its value as a source of power may be diminished, on account of the water used for lockage; and if the regulation of floods is the object in view, the management of reservoirs may be entirely different from the management if the development of power is the aim.

The four uses of water should be considered together. All the countries of the world are facing immense expenditures, not only for the payment of the debts incurred by the war, and for the restoration of devastated regions, but for works of internal improvement, which are necessary. At no time in history has it been more important to study the economic advisability of the projects proposed. There should be no scattering of resources. Efficiency and the avoidance of waste should be the aim, and no project should be undertaken, which cannot be demonstrated with reasonable certainty to be economically justified.

We have not studied the special projects for inland waterways, as we have not had the time. We, therefore, pass no judgment on them. As

we have already stated, certain works of river improvement, and certain canals, may be justifiable, but each project, before it is undertaken, should be proven economically justified, and due allowances made for all expenditures from whatever source.

Water-power developments, of course, should be studied, having in view the possible requirements of navigation. If this is done, and if works of internal navigation are later decided to be advisable, water-power improvement will prove to have been a benefit to navigation.

Railroads.

There is one paper on railroads in the proceedings of the Congress, *viz.*, by M. Toulon, on "Les Chemins de Fer Apres la Guerre." Although our Delegation has no special Sub-Committee on Railroads, we desire to say that we entirely approve of the resolutions submitted in this report. We are specially impressed with the suggestion that the railroads join in making their studies and tests, for the sake of economy and efficiency.

France is the most individualistic country that we have seen. We think that it is too individualistic, and that it has not yet appreciated the benefits of co-operation and the fact that industrial progress depends on the proper balance between individualism and co-operation. France is so individualistic that it has not yet adopted common standards. The result is a waste of effort and efficiency. We have been impressed by the fact that, if France is to trade with other countries, it is very desirable that it should adopt standards conforming essentially to those of other countries; or, that if it has changes to suggest, it may agree with other countries as to those changes.

The suggestion in this paper of M. Toulon, that the interests of the railroads are common, and that economy and efficiency would result from studies and tests in common, seems to us to be obvious.

Committee on Roads.

The only paper presented to the Congress relating to the subject of roads is that of M. Georges Dumont (page 67 of the Proceedings of Section I). The Sub-Committee of the Delegation discussed this paper and other matters presented to it with the Committee of the Congress. Our Committee submitted the following memorandum in reply to the memoranda submitted at the meetings.

During the last few years in the United States the material used in road construction has been principally bitumen in its various forms, cement, concrete, and brick. The different methods in which bitumen has been used are known as the bituminous concrete pavements and bituminous macadam pavements.

A bituminous concrete pavement is one composed of broken stone, broken slag, gravel or shells, with or without sand, Portland cement,

fine inert material, or combinations thereof, and a bituminous cement incorporated together by a mixing method.

A bituminous macadam pavement is one having a wearing course of macadam with the interstices filled by a penetration method with a bituminous binder.

Bituminous concrete pavements are sometimes divided into three classes:

Class A.—A bituminous concrete pavement having a mineral aggregate composed of one product of a crushing or screening plant.

Class B.—A bituminous concrete pavement having a mineral aggregate composed of a certain number of parts by weight or volume of one product of a crushing or screening plant, and a certain number of parts by weight or volume of sand, broken stone screenings, or similar material, with or without a filler.

Class C.—A bituminous concrete pavement having a predetermined mechanically graded aggregate, composed of broken stone, broken slag, gravel or shell, with or without sand, Portland cement, fine inert material, or combinations thereof.

Sometimes when a water-bound macadam pavement has been laid for some time and requires improvement, a thin coat of bituminous material is spread over the surface. While this cannot be considered a permanent construction, it has been used to quite an extent on light traffic roads, with good results. It is specially good as a preventive to dust.

Which of the foregoing kinds of pavement are to be used in any particular case must be decided by conditions, the principal ones being traffic, first cost, cost of maintenance, life of the pavement, and the availability of the material.

In considering the traffic, there must be taken into account, not only the volume, but also the units, of traffic. It will be easily understood that 10 000 tons of traffic in units of 10 tons will injure a pavement more than the same amount of traffic in units of 1 ton. In the former case, the pavement must be given a solidity that will sustain the heavy units.

In considering the matter of cost, it must be remembered that first cost is not the only item that makes up the ultimate cost of the pavement, but the cost of repairs must be carefully considered. Very often a pavement, the first cost of which is great, will be less expensive in the long run on account of the lesser cost of maintenance. It is easily understood, of course, that the longer the pavement will last, the cheaper it will be as a general proposition. It must also be remembered that certain materials, like bitumen, have a certain durability irre-

spective of traffic, while others, like stone, for instance, are worn out or destroyed only by traffic.

The availability of material is always an important consideration. It would be useless to think of a material for road work which is at so great a distance from the point of use that the freight charges would make it too expensive. Often a poorer material should be used when, theoretically, a more expensive and more durable one would be advisable.

The Delegates herewith submit for your information specifications, for, and descriptions of, the different kinds of roads in use in America herein referred to. These specifications are proof sheets of a "Highway Engineers' Pocket Book", which is to be published in the United States in the early part of 1919. They also submit formal contract and specifications of the New York State Highway Commission, covering the construction of all roads used in that State. Also, a copy of a report made by a Special Committee of the American Society of Civil Engineers on "Materials for Road Construction and on Standards for Their Test and Use." In this latter document, special attention is called to the definitions of various terms used in road construction, which will be found on pages 1420 to 1429, inclusive.

Although it was stated at one of the meetings of the Committee that conditions were such in France that brick and cement concrete could not be used to advantage, it was thought best by the American Committee to furnish information regarding these roads to the French Committee.

The Committee, too, would suggest a further trial of cement concrete for road work. It must be remembered that when any new type of road is first used, errors are apt to occur in construction, which give bad results, and, at first glance, it would seem to reflect on the material used, when, as a matter of fact, the trouble is in the method of construction. The character of cement concrete roads in America has been improved very much during the past five years, as a result of which large quantities are being laid in practically all the States doing road work. With the natural tendency of the French engineers to work carefully and to achieve good results, it is thought that, possibly, if another trial is given, taking into consideration American practise, results may be achieved that will be more satisfactory than in the past.

Brick roads have been used in the United States to a great extent, and very satisfactorily. In many portions of the country, stone or other paving materials are extremely scarce, and where a clay, or a clay mixed with shale, can be obtained that will produce a good paving brick, such pavements can be laid with satisfactory results.

If, in France, clays or shales can be obtained which will produce brick that will stand the specifications provided for American brick,

there ought to be little to fear in their use. It must be distinctly understood, however, that the brick must be good, in order to produce good pavements.

Referring specifically to the propositions submitted at the first meeting of the Committee, held on December 20th, 1918, the American Delegates would say as regards methods of construction:

1st.—That they heartily agree with the proposition that broken stone roads have been found to be unsatisfactory for motor vehicles of heavy weight and great speed, and that, consequently, this method of construction should be given up for road surfaces carrying a large amount of traffic. This conclusion has been reached in America, and what is known as water-bound macadam is sometimes used, but only where a temporary roadway is required.

In arriving at this conclusion, the American Delegates wish it to be clearly understood that they recognize fully the value of these water-bound macadam roads during the recent war; that, while they did suffer materially under heavy traffic, yet their character was such that repairs could be quickly made and the roads kept in almost continuous use. This, of course, was expensive, but, in war times, quick results are necessary, rather than cheap ones; and construction methods are perfectly proper and justifiable in war, which would be very extravagant in times of peace.

2d.—That they fully agree with the conclusion that surface applications of bitumen to broken stone surfaces have not been satisfactory for heavy traffic, but that a more satisfactory surface known as "asphalt macadam" can be constructed, by what is known as a "penetration" system, and that it can be laid in the way referred to so that good results can be obtained. In the construction of bituminous concrete pavements, a much more elaborate plant is required, which, naturally, makes the cost of the road surface more expensive. It is thought, however, by many people, that the extra cost is justifiable on account of the greater durability of this class of pavement.

In the memorandum, it is stated that experience has demonstrated that, if carefully constructed, this class of pavement will stand heavy traffic for ten years or more. The American Delegates think this is a rather optimistic view. It depends, however, on just what is considered "heavy traffic". The word "heavy", as applied to traffic, is a very indefinite one, for with the increased weight of trucks that have been in use during the last two or three years, what would be considered heavy traffic five years ago would be medium traffic at the present time.

3d.—The statement that the highest type of asphalt surface is that constructed with a mineral aggregate of sand of very fine nature, to which a proper quantity of dust and asphalt is added, is undoubtedly correct for a city pavement. It is, however, exceedingly doubtful if

such a pavement would withstand the heavy units of motor traffic that are in use at the present time and likely to increase in the future.

4th.—That, as to the use of brick for road construction in France, they feel some hesitancy in making any recommendations, other than what has already been said upon the matter, as they are unfamiliar with the character of shales and clays in France.

Financial Questions.—The American Delegates have been asked for an expression of opinion as to the methods of financing road improvements in France, and the possibility of inducing private companies or contractors to undertake such work, receiving their compensation in a number of annual installments, fifteen such payments having been suggested.

There are submitted herewith advance sheets of a section of the "Highway Engineers' Pocket Book", already referred to, in which are described the various methods of financing such work in the United States, where the funds are invariably raised by the city, town, county, State, or Federal Government, and the contractors are paid in full as soon as the terms of their contracts have been complied with.

Such contracts sometimes provide for the maintenance of the road surface for periods varying from 1 to 3 years, a small percentage of the contract price being retained during the maintenance period.

The methods of raising money by the issue of long-term bonds, short-term bonds, serial bonds, general taxation, and special assessments, are described and their relative advantages discussed.

The cost of paving city streets is generally assessed on the property fronting on the street; but, for the main trunk roads, the cost is met by the town, county, or State—the work they pay for usually beginning or ending at the corporate limits of the town or city, leaving the portions of the road within such limits to be improved by the municipal corporation.

As to the willingness of private companies or contractors to finance road improvements with their own funds and accept payment in a number of annual installments, there can be little doubt—provided such companies or contractors are given entirely satisfactory guarantees of payment. It must be pointed out, however, that they would be obliged to borrow the money, thus paying a higher rate of interest than the State, and that they would probably expect a larger profit and a good rate of interest on all their carrying charges, so that the amount of work done for the same total expenditure would be probably much less than if they received prompt payment in full and release from their obligations. The credit of the State would be better than that of private companies, and it would seem that it should be availed of, in order to secure satisfactory results with a minimum of expenditure and in the shortest possible time.

At the meeting of January 3d, 1919, the Committee submitted for the files of the Commission numerous documents dealing with the construction of roads in the United States.

After an exchange of views, the following conclusions were unanimously carried:

1.—Broken stone roads, which have proved until now sufficient for urban communications, are soon deteriorated by the travel of motor vehicles, and do not agree any more with this kind of travel. The tarring, which has done undeniable service against dust, only very insufficiently preserves the road surface from the wear and tear due to the travel of vehicles of mechanical traction.

2.—New systems of construction have been experienced. Among them must be retained cement concrete and bituminous and brick coatings. Experience extending over a sufficient number of years has shown that the preference to be given to one or the other of these various systems of construction depends on several factors: climate, intensity of travel, cost price, etc. The brick coating in use in America could only be used in exceptional cases in France. Cement concrete roads are only advisable in countries where the materials used in their composition are at hand at advantageous prices.

3.—Roads constructed with bitumen or asphalt aggregates are, unfortunately, very expensive, but they have the advantage of requiring less maintenance than broken stone roads. For an equal travel intensity, they answer much better the exigencies of the travel of motor vehicles.

4.—The price of laying these roads is considerably lowered when this system of construction is applied to broken stone roads, the old broken stone constituting a good foundation.

5.—The reconstruction of the French road system is necessary, on account of its profound deterioration, due to the travel during the war. It would be a fault to restore it to its former state, as thus it could not withstand the travel of motor vehicles, which intensity will grow rapidly, in order to comply with the industrial and commercial requirements, as well as with those of tourists, and the expenses for the maintenance of the road would grow considerably, without giving satisfaction to those who use it. Happily, most of the French roads can make excellent foundations to which it will be sufficient to apply appropriate coatings. On these conditions, it will be possible to adapt the roads to the new requirements without laying out a too considerable capital.

It would be logical that the expenses relative to the improvement and maintenance of the roads should be borne by those who use them, and the borderers who profit by the travel. This principle, admitted and applied in some foreign countries, permits the issue of bonds for the construction and improvement of roads, the capital being guaranteed

by taxation and revenue which are certain and which increase with the intensity of the travel, as, for instance, taxes on motor cars, on essence, etc. Unhappily, the fiscal legislation in force in France does not allow the use of this procedure, and as it is not possible to count on voluntary contributions, it is necessary to have recourse to the budget of the State, "Departements", and "Communes", in order to obtain the necessary allowances to bring the road system to a state capable of facing the new requirements.

If, however, the State, "Departments", and "Communes" could not find the necessary capital, private enterprises could be organized to execute the construction of some well-defined portions of roads, guaranteeing their maintenance during a certain number of years, with the proviso that an annuity, including the old yearly price of maintenance increased by the present plus-value and by a supplement justified by the realized improvements, should be provided.

Though this proceeding may be more expensive than direct construction through the Public Works, it will be necessary, perhaps, to have recourse to it, on account of the circumstances created by the war.

Besides, the study of the financial question will have to be pursued in subsequent discussions with the co-operation of persons well qualified for giving useful advice.

Committee on Agricultural Development.

The various papers relating to this subject are included in Section VII of the reports of the Congress, and contain various conclusions and resolutions which are of great interest. Our Committee, however, has not taken up these conclusions and resolutions in detail, but has considered the subject in a more general manner and has submitted the following memorandum containing its conclusions.

The Section of the Congress which has discussed agricultural questions, finds that the necessary rehabilitation and expansion of this vitally important industry in France should be based on improved financial facilities. The latter, in turn, require modifications, in our opinion, in the banking laws and arrangements of France along several lines, including the following:

1.—Working capital for farmers, to permit them to purchase required mechanical equipment, animals, fertilizers, seeds, etc., should be obtainable from the sale of long-term farm bonds, founded on safe mortgages of sufficiently large co-operative groups of farms, granted under adequate supervision and guarantee of the National Government, with the banks selling such guaranteed bonds given a reasonable commission, so as to make it to their advantage to popularize such guaranteed bonds among the investing public.

2.—Safe and convenient procedures, with standardized blank forms, for establishing chattel mortgages on movable property should be provided, so as to afford satisfactory collateral or pledge to banks authorized to make loans to the owners or prospective purchasers of such property, including industrial equipment, crops, agricultural products, merchandise, etc.

3.—A comprehensive and convenient system of warehouse receipts, bills of shipment, or lading, acceptances by commission houses, and other documentary proofs of the movements of merchandise in transit from their points of origin to points of final destination, and payment should be devised under suitable Government supervision and protected by adequate insurance against loss, so that such records of property may be safely accepted as collateral by banks authorized to make loans to their owners.

4.—With amendments made to banking laws so as to permit the convenient hypothecation of property of various kinds on which loans are sought for periods up to 1 year or more, it is necessary also to consider time deposits in banks for periods much in excess of 90 days, and to see to it that laws and decrees are formulated in a sound legal manner satisfactory to the banking interests proposing to operate under them.

5.—The manner and extent to which the supervision credit and guarantee of the Federal Government of France is pledged to the protection of money lenders, should be published in a very clear manner. Likewise, the advantage of ample working capital should be made plain at once to the French farmers, so that they will not be handicapped, as compared with farmers of other nations, in storing and preserving their products for advantageous sale at home or abroad in ways which should be given full and wide publicity.

The foregoing suggestions are based on practical experience in America. They deal with certain principles which it is hoped may be of benefit in modifying French banking facilities. Obviously, it is out of the question to attempt here to detail further a subject which is so intimately related to existing laws and decrees in France.

Mechanical equipment for French farmers should be adjusted to the soil, climate, customs, and preferences of France and the countries to which it proposes to export agricultural implements. In adapting munitions and other plants to their manufacture, great effort should be made to standardize types of machines and equipment and of all parts thereof, so as to facilitate quantity production and thus to secure the resulting economies.

France could adopt to its advantage American methods of establishing in various sizable cities modern slaughter houses and cold storage plants for all meat products. The same is true of a certain number of refrigerator cars for transporting such products from the rural districts

to the larger cities. This will require modification of the laws and the establishment of effective sanitary supervision of all the branches of this industry, including the central markets.

The drying of fruits and the concentration of fruit juices for shipment, and for stabilizing the wine industries, are steps worthy of most careful development.

Storage of farm products in metallic containers on the farm and the establishment of central silos or grain elevators of concrete, are American customs which seem applicable for use in France, particularly in the devastated area and at a time when a change to new customs is easier than ordinarily. With central storage plants, there should be established a system of official inspection and classification as to quality of produce received, with receipts issued in such a way as to be usable as collateral or pledge at bank.

Fertilizers and soil disinfectants, especially potash salts from Alsace, should be quickly industrialized for export, and be exploited.

The reconstitution of French agricultural methods, in so far as this can be undertaken to advantage, should be decided on as quickly as possible, during the present period of general commercial readjustments. Great aid would follow the wide publicity of, through Government channels, details of recommended changes in procedure and the reasons for their adoption.

Should co-operation be desired from America along any lines, it is best that each specific case be dealt with separately. American capital in substantial sums is not likely to come to the aid of French agriculture, except under conditions satisfactory to American bankers, and, doubtless, on the recommendation of American engineers.

Commercial organization to exploit American methods in France should give due consideration to using for a time at least American supervision, so as to teach the details to French associates.

In France, as in America and other countries, hygienic conditions among the farmers are not as favorable as in the cities. This is due to ignoring well-known public health teachings in relation both to personal hygiene and community sanitation. It can be corrected only by persistent and systematic campaigns of publicity through the aid of practising physicians, health officers of communes, school teachers, and influential citizens, all of whom can advantageously be guided at district conventions conducted by the National Health Council. It is well to remember that the transmission of disease by flies may be a much more serious factor in the future than before the war which has brought millions of foreign troops to France.

Rural welfare movements to increase the comforts of farm life are well worth while, and publicity campaigns to that end should follow similar lines to those suggested for rural hygiene, all with the view of

securing popular and effective local leadership for moulding public opinion.

COMMITTEE ON TECHNICAL EDUCATION.

There are many papers in the proceedings of the Congress dealing with the subject of Technical Education and its various branches. We have had no time to study them in detail. The question of education is very complicated, reaching as it does from the lowest primary education to the highest technical education. We will, however, comment very briefly on some of these papers.

Report by M. G. Wery on "L'Enseignement pratique de la Mecanique Agricole".—Page 5 of the Proceedings of Section VII.—We are entirely in sympathy with the idea of establishing agricultural schools. Our universities in America have many agricultural colleges which do a great deal to aid the farmer in cultivating and harvesting his crops. Our railroad companies, also, by means of instruction cars, disseminate information regarding soils and methods of agriculture. Agriculture is the foundation of the prosperity of the State, and the war has demonstrated that every country, so far as practicable, should make itself self-supporting.

In Section V of the Proceedings, there are three papers relating to instruction in Chemistry and Its Application, by M. Kling (page 7), M. Paul Besson (page 28), and M. Bochaud (page 148).

M. Kling discusses the modifications necessary in technical education in France, having in view its adaption to industrial necessities. We are not competent to judge what changes are necessary, because we are not familiar with the present conditions, but we entirely agree with the general conclusions reached by M. Kling.

M. Besson proposes the establishment of a higher school in applied chemistry.

M. Bochaud discusses the reform in technical education in France.

We are cordially in sympathy with any project for improving education in technical chemistry. This subject offers a great field, one that has been cultivated in the past to a large extent by the Germans, but in which France, the United States, and England, are amply competent to lead. One of the results of the war, we believe, will be to take from Germany the superiority which it has hitherto enjoyed in chemistry. In America, our universities have recognized the importance of this subject, and our technical schools have established courses in Chemistry and Chemical Engineering of the highest character. We believe that France should do the same. We will be glad to send to you any further information which you may desire regarding our schools of Chemical Engineering.

Report by M. Kula on "L'Apprentissage".—Page 152 of the Proceedings of Section VIII.—The training of apprentices is very impor-

tant for any country. In the United States, unfortunately, little has been done in this direction. The attitude of the trade unions, which requires the limitation in number of apprentices, is not favorable to the development of skillful workmen or the cultivation of industrial initiative. In this respect, the individualism in France is superior to the co-operation in America, and the result is that the French workmen are, as a whole, we believe, superior in individual skill to the American workmen. They are more expert and better trained. We have much to learn in America from the French in this respect, and we do not feel competent to advise.

In America, little has been done by the State in training apprentices There are some public schools where manual training is taught, and many night schools and private institutions where trades are taught. As a rule, however, the individual apprentice is left to himself to be trained by his experience in the shop. We, in the United States, need reform in the training of apprentices, but the subject is complicated by the fact that it is intimately connected with the labor problem.

Report by M. Rateau on "Le Developpement a Donner a l'Enseignement de la Mecanique".—Page 83 of the Proceedings of Section III.—With M. Rateau's conclusions we are generally in agreement. The war has greatly increased the interest which has been taken in technical education. It has been a war of engineering. Our young men are thinking now of engineering and its application more than they have ever done before.

However, engineering, that is to say, applied science, offers great opportunities for a young man, not only in the technical branches alone, but in the management of industrial establishments in which engineering operations form the main part. The field and scope of engineering should be brought to the attention of students in the secondary schools, in order that they may know what it means, what subjects it deals with, and what qualities are necessary to pursue it. For most young men, it will offer greater opportunities than the pursuit of the law, medicine, or literary studies. It should be encouraged, therefore, and schools should be provided sufficient to receive all the young men who are properly qualified and who desire to pursue technical studies.

Report by M. Leon Eyrolles on "L'Enseignement Technique Secondaire".—Page 91 of the Proceedings of Section VIII.—The conclusions of this paper are given on pages 117 and 119. With the conclusions of this report we are generally in agreement. The main object of the instruction should be to teach the students to think for themselves. The instruction should be concrete and practical, rather than abstract and theoretical, and should be accompanied by practice in the application of the subjects studied.

We think there is a great tendency in all countries to exaggerate the importance of the work which the school can do. The school cannot

make an engineer. It can teach fundamental principles with which, after having practical experience, a young man will become an engineer.

We believe that a student cannot fully appreciate what he studies unless he can relate it to his experience. If this is correct, the importance of laboratories and of practical experience outside the school is obvious. The object should be to give to the student the fundamental principles in a concrete practical form. Mathematics should be taught concretely, not abstractly, with illustrations drawn from practice.

We entirely approve the suggestion that students in technical schools should be instructed in industrial commerce and in industrial management. Engineering in business and the laws and methods of business should be taught as well as the scientific and engineering principles.

Paper by M. Georges Hersent on "La Reforme de l'Education Nationale".—Page 255 of the Proceedings of Section VIII.—We have read this excellent and suggestive paper with great interest. The conclusions and resolutions are given on pages 271 and 274. We will not take the space to quote them in detail, but we regard them as excellent and would emphasize the following:

> "Que soit favorise par tous moyens le sejour des jeunes Francais a l'etranger des l'age de 15 ou 16 ans;* * *
> "D'une facon generale, que les methodes pedagogiques soient inspirees du desir de former le jugement plutot que d'encombrer la memoire;
> "Qu' une large place soit faite, dans l'instruction, a l'experience concrete et sensible, de telle sorte que l'enseignement remonte de la realite a l'abstraction;* * *
> "Que le personnel enseignant de tous degres soit maintenu en contact permanent avec les progres accomplis hors de France, par des stages prolonges a l'etranger."

We have consistently urged throughout the meetings the desirability of an interchange of students between France and America. We have been struck by the fact that while American students of architecture and the fine arts have in the past flocked to Paris, rather than to any other European city, students of science and engineering as a rule have preferred to go to Germany. We hope that this may be different in the future; but, in order that it may be different, France must offer greater encouragement and opportunity for American students. It is not sufficient for the French schools to admit American students on examination, on the same basis as French students. The student must be judged by his general ability and aptitude more than by the precise studies he has taken, and a system of equivalents must be allowed. Systems of education, and the scope and methods of the different studies, differ in different countries, and a good student from America might not be able to pass a French examination, and *vice versa*. In the past, American students have been admitted to German universities and

technical schools without any examination, if they came with good recommendations from reputable American colleges, and have been allowed to take the courses for which they were reasonably prepared, and the results have been very successful. Thousands of our most eminent scientists, doctors, and engineers have studied in Germany. France, in our opinion, should take a more liberal attitude than in the past, by a system of equivalents and more freedom of studies.

Moreover, France should improve the facilities and equipment of her technical schools, which, we believe, do not now offer facilities even approaching those now offered by many American schools, although the French professors are of the greatest eminence and ability.

As for America, we believe we can assure you that young Frenchmen who desire to study there, will be received with the greatest desire to facilitate their studies and to afford them all possible opportunities.

We believe also that the interchange of professors and assistants, for short periods, would be of great benefit.

In closing, the Delegation sincerely hopes that these meetings have been only the beginning of a more intimate co-operation between the two nations, and that it may be continued and made permanent by the formation of a permanent International Engineering Commission. We feel sure that a suggestion to this end made by your Congress would be met by a cordial and enthusiastic response in America.

J. F. Case, *Chairman,*
George F. Swain, *Secretary,*
Charles T. Main,
L. B. Stillwell,
E. G. Spilsbury,
N. P. Lewis,
G. W. Tillson,
A. M. Hunt,
George W. Fuller.

APPENDIX II

Report made to the final general meeting of the Congress of Civil Engineering, January 4th, 1919, by M. E. Barbet, General Secretary of the Congress.

Work of the Commissions, with the Co-Operation of the Delegation of American Engineers.

The Permanent Commission of the General Congress of Civil Engineers, when it was informed of the imminent arrival of the best reputed engineers of the United States, prepared the programme for their joint work, eliminating everything that they did not consider worthy of the high ability of their guests.

They retained but five groups of questions, which were made the basis of as many commissions.

The first commission was to consider the investigation of our large commercial ports and the railways or waterways destined to serve these ports.

The second, the great problem of water power, that is to say, the motive power supplied by the streams of our mountains.

The third, the reconstruction of our road system, on a basis adapted for the traffic of heavy trucks and automobiles.

The fourth, agricultural questions.

And, finally, the fifth was to consider the question of technical instruction.

The Congress held in the month of March had adopted important resolutions regarding these important questions, examining them only from the point of view of our national interests. But, it had, from its very inception, manifested the intention of invoking an inter-allied session not only, because in quite a few cases the final solutions are dependent on our relations with our Allies, but also because our friends often have good precedents to be studied and good examples to be imitated or adapted to our requirements.

We are now holding a portion of an inter-allied session with the American engineers, and although this period of joint study must be so short, we are already in a position to measure the value of their co-operation. The United States will use these preliminary studies as a basis to bring to us, with their customary cordiality, the aid of their creative and inventive powers.

Below we submit, in accordance with the memoranda offered by the Presidents of the Sections, the status of the work attained by each of them.

First Section.—Maritime Ports and Inland Navigation.—The first commission held on December 19th and 21st, 1918, two meetings,

M. Bechmann presiding, in the course of which, after a cursory description of the present situation, its defects and the causes to which they should be attributed, the general programme of improvements and complementary work was submitted, which is contemplated by the General Congress of Civil Engineering, both in the principal ports (Dunkirk, Havre, Seine Maritime, St. Nazaire, Loire Maritime, Gironde, Marseilles) and in our inland system of navigation, which calls for a more perfect utilization of our great rivers (Seine, Loire, and Rhône), a more complete homogeneity of our system of waterways, the establishment of various new lines of transportation, the creation of some lines of unusual profile, not to mention the questions of organization and exploitation, such as autonomy of the ports, future creation of free zones, intervention of private initiative under various aspects, etc.

There was also an exchange of opinion on various points, which arose in the course of discussion, namely, the prospective sizes of the largest sea-going steamers of the near future, the construction and equipment of the ports, the respective rôle to be played by the waterways and the railways, the order of priority of the work to be undertaken, etc., etc.

The inspection of the "Maritime Loire" and the ports of Nantes and St. Nazaire, on December 27th and 28th, 1918, permitted the elucidation of the questions relative to this region, which seem particularly adapted to serve the traffic between the United States, France, and Switzerland, and to start the examination of the questions with regard to future co-operation of American engineers and financiers.

The next excursion to Marseilles and to the "Etang de Berre" will permit of the resumption of the discussions and the further consideration of the resolutions still pending.

Second Section.—Water Power.—The Section or Commission first heard the report of the "Hydraulic Power Department", describing the resources of the country in hydraulic power.

A part of this power was utilized before the war. Despite the greater difficulties which impeded the utilization of the falls during the hostilities, the percentage of the utilized water power has been considerably increased, but it is intended to push the utilization of electric power very much further, and, in particular, to use it for the electrification of railways.

The Section or Commission then reviewed the large plans now under consideration, contemplating the development of power on the Rhône, the Durance, and the Dordogne Rivers. It first of all recognized the work of General Inspector de la Brosse, whose name is connected with all the successes of French hydrotechnics and of the works resulting therefrom.

In regard to the Rhône, M. Boissonnas summarized with remarkable clarity the various questions, which arise from its utilization, on the one hand for the utilization of the water power of the Upper Rhône and, on the other, to facilitate the traffic between the Mediterranean and Switzerland. He did not forget to mention the irrigation along its course, which would confer prosperity on neighboring regions.

Special conferences were arranged between the French engineers and their American colleagues, so that they could exchange opinions in regard to the great problems arising, while looking at the plans.

The visit which is to be made to Grenoble will make it possible to go more deeply into all these questions, in regard to which no conclusion can be arrived at until our return.

In a second meeting, the Commission very particularly studied the electrification of the railways, and considered in regard to this subject the information supplied by our American colleagues, since in the United States this electrification has already commenced.

Finally, this very morning, a third meeting was devoted to the study of projects relative to the Durance River. The present conditions will prevent the American Delegation from visiting the high valleys of the Durance, but M. Marliot, in a very clear technical lecture, explained the works under preparation. In Marseilles, the orographic plans in relief will complete the explanation and will render it still more impressive than simply an uncomfortable voyage to the spot would do.

Third Section.—Reconstruction of the System of Roads.—This Commission unanimously adopted the following conclusions:

1. The macadamized road which has hitherto sufficed for interurban roads, is being rapidly worn out by the automobile traffic. It is no longer adapted to this kind of traffic. The tar surface, which has no doubt been a preventive against dust, is very deficient in preserving the surface of the road against the wear and tear resulting from the traffic of automobile vehicles.

2. New modes of construction have been experimented with. Among them should be mentioned concrete and bituminous surfaces and brick pavements. The experience of a number of years suffices to teach us that the selection to be made between these various systems of construction depends on a number of facts: climate, intensity of traffic, cost, etc. The brick pavement used in America can only be used in France in exceptional cases. The concrete roads can only be recommended as practical in the countries where the materials entering into their composition are found on the spot and at advantageous prices.

3. The bituminous or asphalt roads are, unfortunately, very expensive, but they have the advantage that the cost of maintenance is less

than that of macadamized roads. The intensity of traffic being equal, they answer very much more satisfactorily the requirements of automobile traffic.

4. The cost of these roads is considerably lessened if the surface is used on top of a macadamized road, the old ballasting of which constitutes a good foundation.

5. The reconstruction of the French system of roads is rendered necessary by the great deterioration resulting from the traffic during the war. It would be a mistake to construct it again as it was before, as it could not resist the automobile traffic which is bound to increase greatly in the future, in order to take care of the industrial and commercial requirements and the requirements of tourists, and the necessary expenses of maintenance of which would increase considerably, without being satisfactory to the users of the road. Fortunately, the greater part of the French roads can serve as excellent foundations, and it will suffice to give them a suitable surface (wearing) covering, and under these conditions the roads can be adapted to the new requirements which will be made on them, without too great expense.

It is logical to have the cost of the improvements and maintenance of the roads defrayed by all those who use them and by the owners of adjoining property who profit from the traffic. This principle has been admitted and applied in certain foreign countries, permitting of the issuing of bonds for the repair of the roads, on the security of the taxes and the assured revenues, which increase as the traffic becomes greater; as, for instance, the taxes on automobiles, on gasoline, etc. Unfortunately, the fiscal legislation adopted in France does not permit of the application of this procedure, and as voluntary contributions cannot be depended on, it is necessary to apply to the State, to the Departments, and to the Communes, for the necessary appropriations to place our system of roads in a condition to satisfy the new requirements.

However, if the State, the Departments, and the Communes cannot find the necessary capital, private enterprises can be formed to carry on the construction of certain well-chosen roads, guaranteeing the maintenance for a certain number of years by means of an annual charge made up of the former annual maintenance charge increased in view of the present higher costs, and a further amount justified by the improvements effected.

Although this process may cost more than the direct construction by the public authorities, it will perhaps be necessary to resort to it, owing to the circumstances created by the war.

An investigation of the financial question must therefore be pursued in the later discussions with the help of those who are qualified to give useful advice.

The eminent President of the Section, M. Heude, did not allude at all in his summary to the paved roads, because this is a well known system and its original construction is quite expensive. But is it not worth more, in certain cases, than the concrete or bituminous forms of construction?

In the north of France, where farming trucks play so important a part, there are a large number of paved roads, the cost of which was apparently reasonable. Our recent visit to Arras, Lens, Bapaume, and Albert has afforded us opportunity to see that, even after the war, the paving was still in good condition, with an excellent surface, while the macadam was terribly worn.

Fourth Section.—Agricultural Reconstruction.—The basis of agricultural reconstruction is primarily the financial question, and the Commission has devoted almost two sessions to this important problem.

I request permission to emphasize somewhat the results of the discussion, for the financial problem is almost the same in regard to industrial, naval, and highway reconstruction, etc.

Commercial credit, limited to 90 days, absolutely does not suffice the farmer, who must await the payment for his harvest, in order to be able himself to pay for fertilizer, seeds, implements of husbandry, etc.

Our law of March 19th, 1910, has therefore been very wise in establishing for farmers the long-term credit, but it must not be forgotten that, on the one hand, this credit is based on a mortgage and that, on the other, the loan cannot exceed 8 000 francs. In a word, this loan applies only to the small farmer, who alone is able to derive benefit from the law.

In the United States, the farmer can borrow by giving a mortgage not only on his land, but also on the personal property which he owns or which he will own from the proceeds of the money loaned. He borrows on his farming implements, on his live stock, on his next harvest, this being accepted as security either in the ground or even after it has been placed in the barn, and without obligation to turn over to the lender the property pledged. In this manner, he is not compelled to sell his grain as soon as the harvest is completed. He can wait for more favorable rates and does not run the risk of being involved in financial difficulties.

As to the lender, he is protected by an extremely severe law, which punishes by a fine and prison any abuse of confidence, whether the debtor wrongfully transfers a part of the security, or whether he borrows several times on the same security.

Finally, even if he borrows on a mortgage on landed property, the debtor retains the right each year, beginning with the fifth year, to clear off the mortgage by prepayment.

These are measures which our French law would do well to imitate without delay.

The security on basis of the harvest permits the dealer in fertilizers to allow 8 or 10 months for payment. It is an individual, guaranteed credit. But, in order that the dealer in fertilizers may be able to do this it is necessary that he, on his part, should have the money, so that he must be able to get credit from a bank, which will advance him the necessary funds after examination of the mortgage transaction, for which he remains responsible.

It is therefore necessary that a bank should be ready to loan money, not for 90 days, but for a very much longer time, or for at least 1 year.

The same remarks apply to the manufacturers of agricultural machines, who are obliged to stock up and who cannot sell except on long payment terms.

Finally, a still longer term is required to assist the large agricultural industries (sugar refining plants, distilleries, breweries, etc.), or to establish new manufacturing plants, to use more modern processes: industries for the supply of meat, based on cold storage; industries for the preservation of perishable foods by drying; industries of canned goods, preserves; rational wine-making industries, production of the syrup or juice of grapes, apples, and other fruits, etc.

For all these industries, credit up to 8, 10, or 12 months no longer suffices. Terms of 4 or 5 years are required, and, consequently, the banks must obtain money which they will not have to repay for 4 or 5 years.

A bank, as a matter of fact, must not tie up its capital, which is the basis of its operations. It can only lend for a given term the money which it receives on deposit for a like term.

Let us consider once more the example of America. Aside from the credit extended to small farmers, there has been established in each State banks of a higher class, which supply money to the manufacturers and to the various agricultural industries. Their working capital (long-term) is in greater part supplied by the State itself. For certain kinds of loans, the rate of interest demanded by the bank must not exceed by more than 1% that on the money paid by the State. We may remark in passing that we see here a precedent for the kind of special bank which we supported before the Congress with the assistance of MM. Victor Cambon and F. Mainie.

Would it be difficult to do the same here in France?

Nothing has been more favorably received by the public than the 3, 6, or 12 month treasury bonds. Why does not the State issue some redeemable in 2 and 5 years. Their popularity would be still more increased, if their transfer between private parties should be authorized, as true bank notes, making it possible to use them as legal tender. The funds resulting from the issuance of such bonds would be transferred to the Grand Agricultural Bank at a rate slightly higher than

that of the bonds themselves, so that the operation would remain lucrative for the State, and it will be seen that in this manner the Agricultural Bank would have all the financial resources which our agricultural reconstruction would demand.

In regard to the guaranteed capital of the bank, it would be constituted by the payments which the Bank of France has agreed to make annually by virtue of the law which confirmed the extension of its privilege to issue bank notes.

The Commission did not think it advisable to go into further details, nor, in particular, to specify rates of interest. It suffices for the present to show in what a very simple manner it would be permissible and lawful to obtain the inexhaustible resources for the powerful bank which we require for the furtherance of agriculture, in order to adapt it for modern industrial conditions. The millions, and even the milliards, which would be necessary, will be furnished eagerly, we might say, by the public, which will be glad to contribute its money for the farming industry if it can avoid running any of the risks ordinarily involved.

Let us repeat, parenthetically, that this same financial method could be applied in the case of all our other industries—mechanical, electrical, etc.

The Agricultural Bank, by its long-term loans, would provide the means to restore in the north of France our old farming industries or to establish new ones in the other parts of the country. It would also assist in creating manufacturing plants to use more recent processes, which could increase to a great extent the profits of agriculture.

It may in fact be stated that if, among the food products of our soil, there are some which are ready for consumption without preliminary preparation, there are, on the other hand, many others which require a preliminary treatment and that such treatment, according as it is simple or highly perfected, will result in products which are either cheap or of extraordinary value.

Consider wine as an example: The juice of the grape requires a special kind of process, namely, fermentation. But whereas the grape, made to ferment by the wine-growers without instructions and without the proper equipment, gives poor wines which, after a few years, sell for less than 5 francs per hectoliter, we see this same grape, treated scientifically by the large champagne houses, producing regularly, unless there are bad years, wines valued at more than 5 francs per bottle. The value given by the scientific process is a hundred times that of the other. A good part of this profit goes to the grower, for a hectare of vineyard in Champagne has a different value from a hectare in the Herault.

The American engineers who went to Nantes, visited the wine establishment of M. J. Bruno, where they tasted one of the most agree-

able champagnes, although it was produced from a very common vine of Algeria and Spain. This result was obtained by very careful technical supervision, beginning with removing from the juices the bad odors of the soil, eliminating the low ferments, and allowing them to ferment at a low temperature with the higher ferments of Champagne. In this manner, it is quite impossible to discover their origin.

Still better, the industry is in a position to concentrate the juice of the grape, the apple, or any other fruit, in a vacuum, and thus produce syrups which can be kept for an indefinite length of time.

In this manner, internal transportation as well as exportation are very economical, since weight and volume are reduced to less than a fourth. Finally, one can store the excess or surplus of abundant harvests, and put them on the market in the years when the harvest is poor. In other words, warehousing is established—a necessary basis for large commercial operations.

In regard to meat, storage is no less desirable in order to stabilize prices. Here, also, applied science solves the problem, based on the application of artificial cold. We owe this industry to the genius of a Frenchman, Charles Tellier, who invented the refrigerating machine and its utilization for the conservation of perishable foodstuffs. Meat is the most important of all, and Charles Tellier constructed the first ship provided with refrigerating plants, to bring to Europe the meats from Argentine or Australia.

France, nevertheless, permitted herself to be greatly distanced by the United States and by England. To-day, we must perforce make up for time lost, and for this it is first of all necessary to create cold storage warehouses in all the cities of France. At the same time, slaughter houses or packing plants can be installed in all the cattle-raising centers, this new agricultural industry finding its regulating market in the cold storage plants in the cities.

The Fourth Section has studied in detail, as was done by the Congress, this entire new organization, the technique of which has been entirely developed, but which, for its proper exploitation, only requires the assistance of enormous funds. This will be one of the first tasks of the Agricultural Bank. Everybody recognizes to-day the enormous advantages which will result herefrom for our agricultural industry.

Finally, based on a report by M. Coupan, with many references, the Fourth Section took up the question of agricultural machines, meto-culture, the enormous need of fertilizers, and notably the synthetic manufacture of nitrates, the disinfection of the soil (by formol, for instance), etc. It was recognized that the example of America was of the greatest interest for the standardized manufacture of all agricultural machines and for the specialization of the producing plants.

We have every hope of an intimate collaboration with our American friends in regard to all these agricultural questions, which our diffi-

culties in the way of food supply places foremost to-day in our thoughts.

Fifth Section.—Technical Instruction.—Inaugurating the sessions of the Commission, the President, M. Hersent, recalled that the object of these meetings was to permit an exchange of opinions, suggestions, and methods in regard to the principal problems of interest for the economical future of the two countries. The question of technical instruction and information takes first rank among these. The years to come will necessitate an enormous effort in production. Now, the productivity of a country depends essentially on the quality of the individuals devoted to the productive industries in all branches of the economic structure. Owing to the dearth of labor which the war has produced in almost all the belligerent countries, the problem of professional training has assumed importance for the entire world. A study of the methods pursued in the various countries, therefore, would be very desirable; and from this arises the interest in sessions such as have been held by the Congress.

It will, however, not be possible to take up the problem of professional education as a whole. It will be wise to restrict ourselves to a few special points.

M. Kula contributed a concise and clear memorandum in regard to the technical training of the laborer. This education should commence with the primary school.

But the true school of technical training must be the school of preliminary apprenticeship, such as the one in Paris, in the rue des Epinettes, which constitutes the bridge between the primary school and the private workshop.

The preliminary apprentice is already a laborer, but the preliminary apprenticeship does not specialize. It is a general education, the purpose of which is to impart to the child a liking for manual work.

Professor Swain states that the problem of education has become universal. It is to be encountered in the United States as well as in France, in particular as regards technical education. He believes that the French education gives too much emphasis to general education, to the detriment of manual and practical training. Laboratory and shop instruction has been used to a certain extent in the United States, but much remains to be done in this direction, especially in the elementary schools, which should direct the child toward a vocation, but Professor Swain insists on the danger attendant on specializing too quickly. He believes that Americans have as much to learn in France as the French have in the United States.

There is no law in force in America in regard to apprenticeship. The régime of absolute liberty prevails. When the worker considers he has learnt sufficiently in a workshop, he goes from enterprise to

enterprise to advance himself. The labor unions sometimes restrict the number of apprentices, in order to avoid a reduction in wages. Furthermore, is excessive use of the "Taylor" methods detrimental to apprenticeship?

In closing the first meeting, M. Hersent stated that the problem, after the war, would be to bring about large production, accompanied by high wages, and this despite a deficit of 3 000 000 workers. The solution could only be found in a serious preparation of the producers for their vocations. Exchange of ideas along these lines could not but promote the solution of the question.

The second session took up the question of technical instruction, secondary and higher.

Professor Swain stated that, in America, the principle of some specialization in secondary instruction is generally recognized as advisable. On the other hand, in the higher engineering schools, there is a tendency to specialize to too great an extent, and a reaction seems probable.

In regard to the desire to have the instruction of the French directed from the beginning of school life toward industrial questions, M. Hersent insists on the necessity of beginning vocational training at an early age, and of making in high school or college a differentiation between students who are likely to profit by classical training and those who are not, so as to direct the latter immediately toward the practical vocations.

The opinion of the Committee was unanimous in regard to the necessity of introducing some manual training beginning with the secondary school.

Professor Swain agrees with the Congress in the necessity of rigorous discipline in habits and methods of the work of the pupils in secondary technical schools. Severe penalties should be imposed for poor work or lack of application. The academic freedom which prevails in many universities and colleges is detrimental to the training of engineers.

Mr. Hunt explained that the systematic training in workshops, referred to in the Thirteenth Resolution of the Congress as following the school instruction, is not usual in the United States, except during the vacations. But certain universities (Cincinnati, Pittsburgh, Boston), and certain chemical schools have tried the experiment of combining studies in school with experience in the shop. The pupil passes alternatively a number of weeks in the school and a like number in the shop, and the results appear to be successful. For this purpose the classes are divided into two parts, so that the technical instruction and the practical instruction are continuous, both in the school and the shop.

A very animated discussion took place in regard to sending American students to France, and *vice versa*.

Professor Swain complained that France had not systematically sought to attract American students, as the Germans had done with great success. We must freely open the doors of our great schools and universities. But the most important thing to do is to facilitate in a practical manner the attendance of American students at high schools in France.

The work of the Fifth Section found an interesting illustration in the visit which was made yesterday to the Central School of Arts and Manufactures, and in the preliminary views which were exchanged.

M. Noel Senator, Director of the School, explained the principles followed in the training of the engineer for industrial occupations. A thorough, general education first in the "lycée" (secondary school), an admission examination for the "Ecole Centrale", tending to eliminate all those not capable of assimilating the higher instruction given in the school—applied science during the first year and higher technology during the other two years. Finally, the obligation for all the students without exception to acquire the technical knowledge which is indispensable to all specialized professions: industrial physics (heat and electricity), the various forms of motors, the construction of industrial structures, the quality of materials and the methods of use, methods of manufacture and transportation, highways and railroads, etc.

Our engineers have a good general training in engineering, and whatever specialty they finally take up, they become competent in a very short time, and capable of rendering valuable services in rapidly improving their industry.

The French method is exactly the reverse of the German method, which does not produce anything but outrageously specialized engineers, who are incapable of breaking away from their original specialization and who are little prepared for the great modern inventions, for these can very rarely succeed, if the inventor is not capable of figuring for himself the forces and power which he will require, or of translating into material and suitable devices the conception of his mind. Maj. Case and Professor Swain submitted the proposition that there be made possible between the United States and France an exchange of students of engineering, stating that already in their country the *beaux arts* (architecture, painting, sculpture, and music) have used and profited much from the French schools, and that the same should be true in engineering, and that, on the other hand, the original and daring methods pursued in America, the intensiveness and rapidity, and the principles of the Taylor system, would give a favorable impulse to our great industries.

These just remarks did not escape the Congress of Civil Engineering, and it was even commented on to what extent Germany, always prompt to lend itself to anything promising it profit, had attracted to itself the students of the Balkans, Italy, and other countries, by lavishing on them diplomas little merited. The competition of the cheap German diploma has injured the foreign *clientele* which we have been accustomed to see in our schools, for the foreign student forms friendly relations with the country which receives him, and when he returns to his own country, he becomes its customer and business correspondent.

It cannot be imagined to what extent this obscure cause has promoted the economic expansion of Germany. We must try to protect ourselves from this, and the suggestion of our American colleagues is quite in line with our desires. It should obviously be generally observed in all the allied countries.

Such is, roughly, the present status of our labors together. The trip, which is to commence this very evening, to Grenoble for the study of the utilization of electric power, to Marseilles to study the harbor, to Lyons to study the future development of this industrial center and the practical utilization of the Rhône as a source of power and as an artery of communication, will contribute something new to our studies. It is also proposed to have a new session of the sections on the return from this excursion. The final conclusions can then be examined, and the basis laid by which the aid of America, so cordially offered, can be availed of in every direction of our reconstruction. May our distinguished guests receive at this time the assurance of our respect for their technical experience and our gratitude for their valuable collaboration.

Excursion to Lens.—The privileged few who took part in the excursion to Lens in the company of the American engineers brought back from this voyage an impression of horror and vigorous hate. It is impossible to express the feeling of anguish which seizes one in traversing these regions, once animated and flourishing, and to-day deserted and showing nothing but ruins and the débris of war material.

At Arras our guests commenced to see clearly that the German shells were concentrated intentionally on the heart of the city, so that nothing should remain of the architectural beauty of which Arras was so proud, no trace of the town hall, the two great Flemish structures, the Cathedral and the Convent of St. Vaast. It will be necessary to destroy what still remains standing of these buildings.

After having contemplated from the top of the famous Vimy Ridge, the scene of the great Canadian victory, the visitors arrived in the district of Sallaumines, Lievin, Lens, which had been injured infinitely more than Arras. Not a wall remained standing. It is the most terrifying chaos that can be imagined, and an engineer naturally begins at

once to think of means by which this mass of wreckage could be removed, which has become dangerous on account of the corpses entombed there, as well as on account of the numerous grenades and shells. Almost a 1 000 000 cu. m. must be cleaned up and carried away. This will not only require an enormous amount of labor, but will correspondingly delay the urgent work of agricultural and industrial reconstruction.

However, we must admire the indomitable energy of our dear and venerated Honorary President, Reumaux, and his eminent colleagues; instead of abandoning all hope in this Dante-like hell, they have already prepared their plans of attack. They will require two years for cleaning up alone, but from the ruins they will secure the materials for the concrete with which they will build 1 000 houses in 1919, and then 2 500 per year until the work is complete.

And the whole world says: The Huns are intoxicated with the pleasure of destruction; they have satiated themselves in the orgy of devastation. It is surely their duty to clean up the results of this orgy. It is for them to come and live in this inferno and incur the risks involved in the clearing up.

What I have stated of Lens applies to all the other ruins which require to be cleared. It would be in the highest degree immoral and unjust to permit the Huns to employ from now on their working population in their own uninjured plants, and to push to the maximum their manufacturing productivity, while we, our labor so impoverished by a barbarous war, in which we have suffered most, should be handicapped for two years by under-production, which renders living so expensive.

It suffices to state the problem in this way, to show that no juridical sophism should prevent us from imposing this forced labor on the vanquished, even after the conclusion of peace, and it will be found that this is a mild punishment for such crimes.

Our American guests add: "No peace plenipotentiary should be admitted to the Conference without having first made a pilgrimage to Lens and other scenes of Hun methods. That is the only way for them to gain the viewpoint to enable them to judge what terms should be imposed on the vanquished and what guarantees should be taken for the future."

In regard to the restoration of the coal mines, which, before the war, furnished up to 8 000 000 tons of coal (almost one-fifth of the French production), it is estimated that it will take about two years to unwater them, and that this will require the installation of 30,-000 h. p.

Photographs will be shown you in a few minutes, representing the plants before the war and their present condition. You can judge for yourselves.

APPENDIX III

January 29th, 1919.

Report Submitted by the Delegation of American Engineers to France to the Four National Engineering Societies

Pending the completion of its formal report, the Delegation of American Engineers to France submits the following statement to the National Societies which it represents:

The French "Congrés Général du Génie Civil," at its meeting on January 15th, 1919, adopted the following conclusion:

"In order to study both the possibilities and the means of co-operation which have been considered between the engineering societies represented by the members of the American Delegation and the representatives of the French Civil Engineers, it would be highly desirable to maintain the contact which has just been established.

"For this purpose the formation of a permanent Franco-American Committee should be the first result of the studies and trips of inspection which have just taken place.

"The American Delegation and the delegates of the 'Génie Civil' unite in expressing a resolution in favor of the immediate formation of this permanent international committee."

A formal resolution to this effect was passed by the Congress, without dissent.

The French members of such Permanent Committee were appointed by the Congress, consisting of the General Secretary and the Presidents of the five Sections or Committees with whom the members of the American Delegation had been closely working since their arrival in France, *viz.*:

The Committee on Ports and Navigable Waterways
" " " Water Power
" " " Roads
" " " Agricultural Development
" " " Technical Education

The members of the American Delegation were requested by the French engineers to act as the American members of the Permanent International Committee. The Delegation declined to do this, explaining that it represented the four National Engineering Societies of America, to which Societies it must report, and in whose hands any permanent action must lie.

To meet the desire of the French engineers, however, for the immediate creation of an International Committee, and in view of the fact that the Delegation still has some work to do in preparing reports and information for transmission to the French Committee, the members

of the Delegation consented to act temporarily as the American members of the International Committee, promising to bring the matter to the immediate attention of the Societies they represent, and to secure immediate action if possible.

In view of these facts, the American Delegation, at a meeting held January 27th, 1919, unanimously passed the following resolution:

"*Resolved*, that the Delegation bring to the immediate attention of the National Societies, which they represent, the facts with reference to the formation of a permanent Franco-American Engineering Committee, and urge on the Societies that they take immediate action to constitute the American representatives upon such a Committee."

(*Signed*) George F. Swain,
Lewis B. Stillwell,
Charles T. Main,
A. M. Hunt,
George W. Fuller,
E. Gybbon Spilsbury.

ITEMS OF INTEREST

The Committee on Publications will be glad to receive communications of general interest to the Society, and will consider them for publication in *Proceedings* in "Items of Interest". This is intended to cover letters or suggestions from our membership covering matters which are not of a technical character. Such communications, however, must not be controversial or commercial.

Report of the Finance Committee to the Board of Direction, June 16th, 1919.

JUNE 12th, 1919.

BOARD OF DIRECTION
AMERICAN SOCIETY OF CIVIL ENGINEERS.

GENTLEMEN.—The Finance Committee of the Board, at a meeting at which the majority of the Committee was present, decided unanimously to recommend to the Board what we consider to be moderate increases in salaries of members of the clerical staff, as recommended to us by the Secretary of the Society in a letter addressed to the Chairman of the Committee on May 21st, 1919, accompanied by an interesting analysis of the increase in the cost of living during recent years. We recommend also that payments to Mr. McMinn be provided for through a budget account independent of that for clerical help.

There was referred to the Committee on April 14th, 1919, the question of further contribution by the Society to the cost of recataloguing the library. The majority of the Committee has made a personal examination of the present catalogue system and has discussed the matter in detail with the Librarian, Dr. Craver. Admitting that the catalogue of the 67 000 volumes belonging to the Society, which were transferred to the Engineering Societies Library, may have been more thorough and complete than those of the libraries of the other Founder Societies, we are convinced that one complete catalogue should be made, and that this work should be done as soon as possible. We believe also that the Board should no longer defer favorable action on the request for a contribution for this purpose, but that it should appropriate the sum of $2 500 therefor, the same sum as that provided by the other three Founder Societies. This recommendation is made in the expectation that at least as much more will be called for as our contribution to the cost of this work.

Respectfully submitted,
Finance Committee,
NELSON P. LEWIS, *Chairman,*
H. S. CROCKER,
GEORGE H. CLARK.

New Filtration Plant for Sacramento, Cal.

Charles Gilman Hyde, M. Am. Soc. C. E., Professor of Sanitary Engineering at the University of California, has been employed by the City of Sacramento as Consulting Engineer in the construction of a water filtration and pumping plant, for which bonds to the amount of $1 800 000 were voted by the people in June, 1919.

Until recently Professor Hyde was in the United States Army service, having been commissioned Major in the Office of the Surgeon General, at Washington, D. C., and having served in that capacity for more than a year. He has had extensive experience as a water supply engineer. Fifteen years ago he designed the filtration plant at Harrisburg, Pa., and acted as Consulting Engineer during the period of construction.

The filtration plant at Sacramento is to be of the mechanical or rapid sand type, filtering the water of Sacramento River. Its nominal capacity will be 30 000 000 gal. per day, and sulphate of alumina will be used as the coagulant. This will be the first modern municipal filtration plant in California and is expected to be in operation early in 1921.

For more than 50 years, Sacramento's water supply has been unfiltered, and at times it has been so turbid and muddy that it could hardly be used. The decision of the people to build a filtration plant was the result of recommendations made by Professor Hyde, and Messrs. George H. Wilhelm and Frank C. Miller, in 1916, after they had made a diligent and exhaustive investigation of all possible sources of water supply for Sacramento.

Committee on Honorary Membership

At the meeting of the Board of Direction held in Minneapolis, Minn., on June 16th, 1919, the following gentlemen were appointed a Committee to nominate those considered eligible for Honorary Membership in the Society: President F. S. Curtis; Past-Presidents Chas. D. Marx, Clemens Herschel, Geo. H. Pegram, and A. N. Talbot; Vice-Presidents Nelson P. Lewis, Leonard Metcalf, John F. Coleman, and Herbert S. Crocker.

The James Watt Centenary

Appropriate ceremonies will be held at Birmingham, England, on August 25th, 1919, to celebrate the centenary of James Watt. J. P. O'Donnell, M. Am. Soc. C. E., of London, was appointed by President Curtis to represent the American Society of Civil Engineers at the celebration. Illness, however, will prevent Mr. O'Donnell's attendance, and he has asked Sir James Ball to take his place.

Report of the Library Committee, on the Engineering Societies Library, to the Board of Direction, June 16th, 1919.

June 3d, 1919.

To the Board of Direction:

All the functions for the Library Committee prescribed by the Constitution have for years been performed by the Secretary of the Society. It remains, therefore, for your Committee to report the actions of the Engineering Societies Library Board, on which it represents the Society.

Since January 1st, 1919, two actions of unusual interest and prime importance have been taken: (1) to recatalogue and shelve as one homogeneous library the several collections of books brought together by the Founder Societies; (2) to use the system of cataloguing and indexing developed by the Institut International de Bibliographie, which is the Belgian extension of the Dewey Decimal System prepared under the direction of Paul Otlet, of Brussels, General Secretary of the Institut.

Cataloguing of new material by this system has been in progress for many months as part of the routine work of the regular Library Staff. It has, however, been impossible for this Staff to devote the necessary time to recataloguing the older books, including a miscellaneous accumulation of books and pamphlets which had never been catalogued. As has been stated to the Board in other communications, the Director of the Library estimates that two years' time of a special force will be required for this work, and that the total expense will be about $25 000. On recommendation of the Library Board, United Engineering Society requested the Founder Societies to provide $2 500 each per year for two years. Three Societies have already voted this special appropriation. Because repeated and urgent requests have been made that the recataloguing should proceed without further delay, and because money from some of the Societies has become available, the nucleus of a special force was put to work on May 1st. This force will be increased, and the work pushed more vigorously as the methods are developed.

On June 1st, 1919, the Engineering Societies Library contained about 200 000 books, of which 18 774 had not been catalogued at all. The number of visitors has averaged about 78 per day, since January 1st. This Library is more than a collection of books. Through its Service Bureau persons at a distance can use information on its shelves. Searches are made in response to mail or wire inquiries, bibliographies, photostat copies, translations, and abstracts being furnished at cost, and many questions answered without charge. Last year more than 1 700 orders were filled, many of them from remote places. For this work $10 000 were received. For the first five months in 1919, there have been received 1 329 orders for which the charges amount to about

$7 900. Since October, 1918, an index of current technical literature has been prepared monthly by the Library, in co-operation with the staffs of the Founder Societies. This index is printed in their publications in part or whole and by a few other Societies which have made suitable arrangements.

Respectfully,

JOHN A. O'CONNOR,
ARTHUR P. DAVIS,
WILLARD BEAHAN,
CHARLES WARREN HUNT,
ALFRED D. FLINN, *Chairman.*

Founder Societies' Finance Committee on Joint Activities

For the purpose of acting on matters of mutual interest involving the expenditure of funds, there has been set up a Founder Societies' Finance Committee on Joint Activities composed of the following:

American Society of Civil Engineers.—Nelson P. Lewis, Chairman, Finance Committee, and Dr. Chas. Warren Hunt, Secretary.

American Institute of Mining and Metallurgical Engineers.—J. V. N. Dorr, Chairman, Finance Committee, and Geo. D. Barron, Treasurer.

American Society of Mechanical Engineers.—W. E. Symons, Chairman, Finance Committee, and Walter M. McFarland. Secretary Calvin W. Rice is also expected to attend the meetings of the Committee.

American Institute of Electrical Engineers.—N. A. Carle, Chairman, Finance Committee, and F. L. Hutchinson, Secretary.

Society *Transactions* for Sale

R. S. Coleman, 314 Federal Building, St. Paul, Minn., administrator of the estate of the late Clarence Coleman, M. Am. Soc. C. E., wishes to dispose of certain volumes of *Transactions* forming a part of the estate. The set is nearly complete and consists of 83 bound volumes for the years 1873-1917 (except 1885) and three volumes of indices. The first 31 volumes are bound in sheepskin and the remaining 52 volumes and three volumes of indices are bound in half morocco. All are in excellent condition and are now in book cases in the United States Engineer Office, Duluth, Minn. The price of the 83 volumes is $100 f. o. b. Duluth.

Committee to Recommend the Award of Prizes

President Curtis has appointed as a Committee to Recommend the Award of Prizes of the American Society of Civil Engineers, Messrs. A. S. Crane, M. Am. Soc. C. E.; Ralph Modjeski, M. Am. Soc. C. E.; and Arsène Perrilliat, M. Am. Soc. C. E.

Report of the Committee on Special Committees, to the Board of Direction, June 16th, 1919.

To the Board of Direction:

Gentlemen.—Your Committee on Special Committees has been in correspondence with all the Chairmen of the Special Committees as now appointed.

Committee on Development.

The Chairman of the Committee on Development, though claiming that his Committee does not come under the class of Special Committees designated in Article 6, Section XII of the Constitution, reported to date of May 29th, 1919, by enclosing a copy of a preliminary report, and stating that, since that time, the Committee had been working along the lines indicated in that report; that a five-day meeting had been called to be held from June 11th to 16th, 1919, in Minneapolis, Minn., at which time it was expected a general progress report would be made to the Board of Direction; expressing the hope that the Committee would be able to supply the Board at the opening meeting of the Convention on June 16th, with copies of its progress report, sufficient in number for distribution to members present; and suggesting that the Board arrange a time for the discussion of this progress report.

The Committee on Special Committees suggests that this be done, and that the Committee be continued in order that it may conclude its investigations and render a final report in time for presentation before or at the Annual Meeting of this Society.

Committee on Reconstruction.

Nelson P. Lewis, Chairman of the Committee on Reconstruction, advises that this Committee will submit to the Board of Direction its Final Report and ask to be discharged at the Minneapolis meeting.

Inasmuch as a National Service Committee has since been established by Engineering Council, with headquarters in Washington, D. C., representative of all branches of the Engineering Profession, the objects for which the Reconstruction Committee was created appear to have been accomplished.

The Committee on Special Committees, therefore, reports in favor of approving the discharge of the Committee on Reconstruction.

Special Committee to Codify Present Practice on the Bearing Value of Soils for Foundations.

Robert A. Cummings, Chairman of this Committee, reported verbally on June 7th, 1919, that the work of the Committee had been interrupted by the war, and that little had been done; that during the Spring, work

had been resumed actively and was now in progress; that while no Progress Report might be ready for the Minneapolis meeting, results might be expected at the next Annual Meeting of the Society. Mr. Cummings further reported that extensive and interesting tests had been made by the Bureau of Standards, in co-operation with this Committee, which will be of great value to the Society, and that the work should be continued.

The Committee on Special Committees concurs in the view that the Committee should be continued.

Special Committee on the Regulation of Water Rights.

F. H. Newell, Chairman, has been written to twice by the Chairman of the Committee on Special Committees, for information as to the work of his Committee, but, so far, no response has been received.

It is believed that little work has been done by this Committee, especially since the war has claimed the activities of its members.

Your Committee on Special Committees makes no recommendation at this time, but raises the question whether the object sought in the appointment of this Committee and to which it is addressing itself, is not impossible of accomplishment? If so, it would appear unreasonable to ask continued service of the members of a Committee in a field with such serious, if not insurmountable, legal and practical difficulties as here prevail.

Special Committee on Stresses in Railroad Track.

A. N. Talbot, Chairman of this Committee, advises that since its Progress Report at the Annual Meeting, the Committee has held a meeting at Chicago, Ill., in March, and discussed plans. It has been planned to hold another meeting sometime after the data of the tests have been presented to it. During 1919, the staff of the Committee has been working on the data of the tests accumulated in 1918. This work has taken more time than was expected, but it is now thought that the material will be ready for the Committee by the middle of this summer. These results include information on the effect of counterweight of locomotive on stresses in the rail, loads on and stresses in ties, and the transmission of pressure through ballast to roadbed.

It is believed by the Committee on Special Committees that the Committee on Stresses in Railroad Track is pushing its work with all possible diligence, and should be given such time as is needed to complete its work.

Special Committee on Roads.

Your Committee on Special Committees to which was referred the request for the appointment of a Special Committee on Roads or High-

ways, has conferred with a number of members of this Society closely in touch with the pending projects of the Government in this engineering field, with the work being done by the authorities at Washington, D. C., the Bureau of Public Roads, the Association of Highway Officials, the American Society for Testing Materials, and others, and with the past and present efforts of this and other Societies to assist in an advantageous solution of highway problems.

A digest of the arguments for and against the appointment of such a committee can be submitted if desired by the Board of Direction.

Your Committee is of the opinion that the disadvantages of appointing a committee to make further research in this field, outweigh the advantages.

On the other hand, the magnitude of the task assumed by the Government, and the importance of the basic principles which underlie it—more particularly the principle that the work shall be planned so that when the task is accomplished, there shall be a well designed and built National system of continuous highways—are such, that your Committee recommends that a Special Committee on Highways shall be appointed, consisting of three members, the duty of which shall be to keep in touch with the development of the Government's plan for the construction and financing of National highways, and to advise the American Society of Civil Engineers of these Governmental plans and activities, by the submission of frequent or periodic reports or critical reviews, accompanied by such data as are necessary to indicate the scope and character of the work in progress from time to time.

Special Committee to Prepare Engineering Problems and Judge Competitions for Technological Schools.

Your Committee on Special Committees, to which was referred the matter of having the American Society of Civil Engineers interest itself in promoting the work of preparing engineering problems for competition and judging the awards to be made, report as follows:

This matter was originally referred to a committee consisting of Messrs. Charles D. Marx, G. J. Fiebeger, and Edgar Marburg (now deceased). The work of the Committee was interrupted by the war, but the Chairman of the Committee on Special Committees has corresponded both with Professor Marx and Col. G. J. Fiebeger, and finds that the majority of the Committee had determined that it was not desirable that the National Engineering Society should undertake to conduct a competitive programme in relation to engineering theses; and that Professor Marburg before his death, by letter, addressed to Professor Marx, under date of April 3d, 1917, concurred in this opinion.

Inasmuch as this seems to have been the unanimous opinion of the Committee appointed, your Committee on Special Committees recommends that no action be taken at this time.

Enclosed herewith are copies of letters from Professor Marx and Col. Fiebeger.

All of which is respectfully submitted.

JOHN W. ALVORD
LEONARD METCALF
ARTHUR S. TUTTLE

Appropriations for Government Engineering Work

When the Sundry Civil Bill was signed, it gave the Geological Survey a total of $1 461 353.50 and the Bureau of Mines $1 201 897.

The important item covering the Geological Survey's topographic map work was reduced to $289 000 by the House, increased to $425 000 in the Senate and approved for $325 000 by the House confreres. It is understood, however, that the Survey is to receive an additional $100 000 from the Army's topographic appropriation.

Engineering Council interested itself in having this appropriation increased because of the possibility of complete topographic maps for the Engineering Profession. It was estimated that $500 000 would enable the Survey to complete the topographic map programme in twelve and a half years. It is now hoped to get the remaining appropriation necessary through as an urgent deficiency appropriation.

Honors for George Ellery Hale

George Ellery Hale, Director of the Mount Wilson Observatory and Foreign Secretary of the National Academy of Sciences, who has been for the last ten years a Correspondent of the Academie des Sciences, Institut de France, has received the unusual honor of election as Associe Etranger, taking the place of Adolph von Baeyer, declared vacant by the Academy. The Foreign Associates are limited to twelve, and the high distinction has been held by only two Americans—Simon Newcomb and Alexander Agassiz.

The National Research Council, upon the presentation and acceptance of Dr. Hale's resignation as its Chairman, and the election of James R. Angell as his successor, created and bestowed in perpetuity upon Dr. Hale the title of Honorary Chairman, in recognition of his services to the National Research Council and to Science and Research by indefatigable efforts that have contributed so largely to the organization of science for the assistance of the Government during the war, and the augmentation of the resources of the United States through the newly intensive cultivation of research in the reconstruction and peace periods that follow.

Col. Parsons' Farewell Address to the Eleventh Engineers

At the regimental dinner of the Eleventh Engineers, A. E. F., at the Hotel Pennsylvania, New York City, on April 30th, 1919, Col. William Barclay Parsons, Engrs., U. S. A., M. Am. Soc. C. E., said farewell to the regiment he had commanded in France in the following words:

"My men. I do not say officers and men, but, simply, my men. This is probably the only opportunity that I shall have to say a word to you all collectively.

"In a few hours the process of disintegration will begin, and in a few days this regiment will exist in history only and the close comradeship that has held us for nearly two years will be at an end.

"You and I have been together during that time. We have marched together by day and by night, we have worked and fought together in sunshine and in storm, in heat and in cold. We have been together and have seen our comrades fall, not to rise again, and we have stood side by side, with heads uncovered, as we laid them to rest in the far-away soil of France. Such a comradeship cannot be broken without a pulling of the heartstrings. As you go on your several ways you will take with you my ever-abiding affection, and I hope that you are leaving me yours.

"There are a few things that I ask you never to forget: First and above all, the record of our regiment. That record, without a stain, without a spot, is yours. You made it, it is now yours to keep. In life let it be an inspiration to you, and when moments of temptation come, as they will come to all of us, let us remember that we belonged to the Eleventh, with its record second to none, and that it is the part of each one of us to live up to that record. You were willing to die for it; are you now willing to live for it?

"It is right that men should make every effort, as men in Paris are now doing, to prevent war, but don't fool yourselves that there will be no more wars. Just so long as men are men, there will be wars and you will be called upon again. Unless the next war comes very soon, I fear that the operation of time will cut me out and it will be a younger and better man who will lead you on. For him, the best that I can ask is that you will give him the same loyal faithful support that you have given me.

"But while waiting for the next war of arms, remember there is always going on the war of good citizenship. In the war just ending you have done your duty; in the days to follow there is still a duty to perform. In your hands you have held the rifle and the pick, the weapons of the engineer; now you hold in your hands the ballot, the weapon of a good citizen. Use the latter as you have used the former, in the service of your country; and insist, as members of the Eleventh Engineers, on the highest ideals of law, order, decency, liberty and fair dealings to all men.

"I cannot at this moment shake the hand of each of you, but, before we separate in the next few days, I hope that every one of you will come to me and let me give you a parting clasp. May God bless you,

men, and keep you and give you, each and every one, all health, strength, happiness, and success. May you triumph in the battles of life, and having gained that victory enjoy 'the peace that passeth all understanding'."

Benjamin G. Lamme Awarded the Edison Medal

Benjamin G. Lamme, Chief Engineer of the Westinghouse Electric and Manufacturing Company, on May 16th, 1919, was awarded the Edison Medal by the American Institute of Electrical Engineers for "invention and development of electrical machinery." The Edison Medal was founded by friends and associates of Thomas A. Edison, and is awarded annually for achievement in electrical science, electrical engineering, or the electric arts. Elihu Thomson, George Westinghouse, Alexander Graham Bell, Frank J. Sprague, and Nikola Tesla are among those who have received the medal.

Westinghouse Company Establishes Memorial Scholarships

The Westinghouse Electric and Manufacturing Company has decided to establish a number of technical scholarships as an appropriate war memorial to its 8 000 employees who entered the service of the United States in the Great War. Under certain conditions a scholarship will entitle the successful candidate to pursue a four years' course in any technical school or college he may select. He may also choose the branch of engineering he wishes to follow. Scholarships, carrying an annual payment of $500, will be granted for one year only, but will be continued for the full four years. The candidates for scholarships must be sons of employees of the company or its subsidiaries, who have been in good standing for a period of five years.

Proposed Legislation to Strengthen the Patent Office

The Patents Committee of Engineering Council has conferred with a similar committee from National Research Council and with the staff of the Patent Office on developing improvements in the method of dealing with patents in the United States. As a result of the report, approved by National Research Council and also by Engineering Council as the report of its Patent Committee, remedial legislation has taken form.

Three bills have been introduced, known as H. R. 5011, a bill to make the Patent Office independent of the Department of the Interior, or any other Department, and to simplify the recovery of damages or profits for infringements of patents; H. R. 5012, a bill to establish a single Court of Patent Appeals; and H. R. 7010, a bill to increase the force and salaries in the Patent Office.

Chairman Charles A. Terry of the Patents Committee has requested that representatives of Engineering Council write to their Congressmen urging the passage of these bills, and so far as convenient, request their friends to do likewise.

American Firm to Rebuild Nancy, France

A contract, which at tentative figures involves $250 000 000, and which may exceed $500 000 000, has been signed by the Vulcan Steel Products Company, of New York City, for rebuilding the war-destroyed area in the Nancy district of France. The contract calls for replacing public buildings, factories, dwellings, roads, bridges, churches, in fact, practically everything that was razed by the Huns.

This is the first contract of which there is authoritative information for war reconstruction work. There have been reports that the rebuilding of parts of France and Belgium would be undertaken by American companies, and predictions that much American steel and building material would go to France, but the disposition in industrial circles has been to believe that the reconstruction would be done by the afflicted countries.

Associated with the Vulcan Company in the Nancy enterprise are two large contracting concerns, the McClintic-Marshall Construction Company and MacArthur Brothers Company. Negotiations have been in progress ever since the signing of the armistice between Rodney D. Chipp, Secretary of the Vulcan Company, and the Committee of Nancy. The $250 000 000 figure appears in the contract, but it is not a definite amount, and it is estimated that before the work is completed half a billion dollars will have been spent.

The contract was signed some time ago, but actual work has awaited the Peace Treaty. Now it is hoped to begin within a short time. The question of exchange and the French indemnity from Germany enter into the case. At present, exchange is heavily against France, but it is expected by the contractors that before any large purchase of material is made here the premium on the dollar will be much lower. The indemnity is to be used in part for the reconstruction of devastated areas, but the work will not await full payment. According to an officer of one of the contracting companies, the French Government will issue securities against the indemnity.

In many respects the plans are still incomplete because of the vastness of the undertaking. No estimates are available as to the quantity of particular materials that will be needed, but there will be much steel and concrete construction, that being the type of factory discussed with the Committee of Nancy. The new buildings will probably conform to the French idea of stone buildings.

Whether the material to be used shall come from this country or not will depend entirely on prices, as the contractors will buy where they can get material the cheapest. Many building materials are lower here than abroad, especially structural steel.

The McClintic-Marshall Company and MacArthur Brothers Company are among the largest contracting concerns in the country. The

first named concern has placed many of its former contracts for structural material with the American Bridge Company, which is a subsidiary of the United States Steel Corporation.

One of the largest stockholders, who is also a Director, in the Vulcan Steel Products Company is T. Coleman du Pont. The company, it is reported, is bidding for contracts for rebuilding other devastated areas.

Finding Concealed Water Pipes

An electrical method of determining the location of pipes concealed within walls, has, according to the *South African Journal of Industries,* recently been patented. The apparatus is made up of two sets of coils placed on the ends of a magnet bar. One set of coils receives alternating or vibratory current, and the other is connected to a telephone. The balance is first established so that no sound is heard in the telephone. When the device comes near the metal piping this disturbs the balance, and a sound is heard, thus indicating the locality of the pipes. The value of this invention exists in the saving effected in disturbing as little of the wall as possible when repairs to pipes are necessary.

Federal Electric Railways Commission

Appointment by President Wilson of the Federal Electric Railways Commission to find a solution of the street railway problem throughout the country, was announced on June 5th, 1919, by Secretary Redfield. Composing the commission are Edwin F. Sweet, Assistant Secretary of Commerce; Royal Meeker, Commissioner of Labor Statistics, Department of Labor; Louis B. Wehle, General Counsel, Finance Corporation; Charles E. Elmquist, President, National Association of Street Railway and Utilities Commissioners; Charles W. Beall, of the Investment Bankers' Association; Philip H. Gadsden, American Electric Railway Association, and William D. Mahon, Amalgamated Association of Street and Electric Railway Employes. The members of the Commission serve without pay.

Engineering Societies Employment Bureau

The service performed by the Engineering Societies Employment Bureau, 33 West 39th Street, New York City, which is operated under the direction of the Secretaries of the four Founder Societies, is shown by these figures: From December 1st, 1918, to June 30th, 1919, 3 280 applicants registered their names and qualifications for positions. Of these the records show that 629 were placed. It is probable that more than this number secured positions through the Bureau, but have failed to notify it. The number of positions listed during the above period was 1 042.

Roads and Fruit Trees

Comforting our fear that "the example of Europe" with regard to the shaded road may be "too remote for emulation" by American communities, the Countess von Krackow urges the use of fruit trees in the Continental manner. The picture she paints is persuasive as it is beautiful, observes an editorial writer in the *New York Times*.

The wayside soil, instead of growing a tangle of brush and weeds, is examined by experts and set out with trees bearing pears and apples, cherries and plums. In the Spring there are bowers of blossoms, white and pink; in Autumn the ripening fruit dapples the landscape with color. And all Summer long there is the comfort and the loveliness of leafy verdure. If any wayfarer is tempted to pluck a spray of vernal bloom, the guardian of law is there. When the first fruit ripens, children gather and sell it to the passing motorist. As the crops mature, the countryside turns out, including the poorhouse, and gathers it for the market. Sometimes the yield is sold to jobbers, and these send out agents to guard it and crews to gather it, who all live in rustic shelters among the trees. In addition to paying largely for the upkeep of the road, the arrangement provides labor and considerable chance earnings for the people of the countryside. It is a truly Arcadian poem of rustic happiness, a more than Arcadian picture of thrift.

Deeply as we are persuaded, however, a doubt persists as to the possibilities of local emulation. On the densely populated Continent, land has a value which it does not possess with us, who see limitless tracts still waiting to be claimed for agriculture. When our wayside trees flower and bear fruit they present a graphic measure of the honesty of the traveling public, for perhaps it is only a measure of our National respect for law—it is the reach of the arm to pluck flowers, or of the club to bring down fruit. The picture of wayside harvesters may bring tears to eyes long dry; but they would be idle tears, the tears of a longing that seems hopeless. Three dollars a day is the current price of our own thrice happy villagers, and at that the employer has to entreat them, as if on bended knee, in the name of his common humanity. All about there are wonderful old orchards, falling a prey to codling moth and cedar rust, to fire-blight and San José scale; and few but the farmers who plant and reap in Wall Street can afford the labor to reclaim them. If the cause of the shaded road depends upon the wayside orchard, its future seems dubious indeed.

National Research Fellowships

The National Research Council announces further appointments to National Research Fellowships in Physics and Chemistry. Previously six appointments were announced, three in Chemistry and three in Physics. The object of the National Research Council in maintain-

ing a system of research fellowships is to promote fundamental research in Physics and Chemistry primarily in educational institutions in the United States. Fellowships are awarded to persons who have demonstrated a high order of ability in research, for the purpose of enabling them to conduct investigations at educational institutions which make adequate provisions for research in physics and chemistry. The new appointments are as follows:

In Chemistry.—Warren C. Vosburgh, of New York City, B. S., Union College, 1914; A. M., Union College, 1916; Ph. D., Columbia University, 1919; Research Assistant to the Professor of Chemistry at Columbia University for the past six months.

George Scatchard, of New York City, A. B., Amherst College, 1913; Ph. D., Columbia University, 1917; Formerly Research Assistant to the Professor of Chemistry at Columbia University and Instructor in Organic Chemistry; First Lieutenant, Sanitary Corps, U. S. A.

In Physics.—Ernest F. Barker, of London, Ont., Canada, B. S., University of Rochester, 1908; M. A., University of Michigan, 1913; Ph. D., University of Michigan, 1915; Professor of Physics, Western University, London, Ont., Canada, since 1915.

Albert Edward Caswell, of Eugene, Ore.; A. B., Leland Stanford University, 1908; Ph. D., Leland Stanford University, 1911; Professor of Physics, University of Oregon, since 1917.

The members and acting members of the Research Fellowship Board are as follows: Wilder D. Bancroft, Henry A. Bumstead, Simon Flexner, George E. Hale, Elmer P. Kohler, A. O. Leuschner, Robert A. Millikan, Arthur A. Noyes, and E. W. Washburn.

Edison Advocates "The Square Deal"

Thomas A. Edison, in a message to the Annual Convention of Edison Dealers, held in New York City, in June, 1919, said:

"A new order of things is emerging from the events of the last five years. Whatever may intervene, the ultimate result is going to approach more closely a square deal—for labor, for capital, for the merchant, for the farmer, for every one. The employer who is not square with his employees, or the employee who is not square with his employer, is going to be out of step with the times.

"Demagogues may muster a following of illogical radicals who advocate injustice as a means of gaining justice, and stiff-necked reactionaries may selfishly oppose the progress which destiny has decreed as humanity's reward for the sacrifices that have beeen made, but in the end there will prevail a just and honest basis for the relations between capital and labor.

"This new relationship cannot be legislated into existence. It will spring from the conscience and patriotism of the people. The time is coming when the unjust employer and the disloyal employee will share equal odium in the esteem of society at large.

"The square deal is fatal to radicalism. There can be no social revolution in the United States or Canada for the very simple reason that our Government and the Canadian Government are founded on the idea of giving everybody a fair show. There will be few disturbances of consequence if a majority of us adopt the square deal as our business creed and our social creed. One lone man who believes in the square deal and has the courage of his convictions might very possibly convert a whole community. Accordingly, the good citizen to-day, in addition to conducting his individual business in harmony with the Golden Rule, has the duty of raising his voice and using his influence in behalf of justice for all—justice as much for the railroad corporation as for its employees, and for the common laborer as well as for the highly skilled artisan."

The Hudson Tunnel

President Wilson signed a bill on July 12th, 1919, which gives the assent of the Government to a compact between the States of New York and New Jersey for building a tunnel under the Hudson River between New Jersey and New York.

The organization of the New York State Bridge and Tunnel Commission and the New Jersey Interstate Bridge and Tunnel Commission was completed on July 1st, at a meeting in the office of the Joint Commission at 115 Broadway, New York City. The previous appointment of the following was made effective:

Clifford M. Holland, chief engineer, at a salary of $10 000 a year; Jesse B. Snow, principal assistant engineer, $5 400; Milton H. Freeman, resident engineer, $4 200; Ole Singstad, designing engineer, $4 200; Ronald M. Beck, assistant engineer, $3 000; Miss Rheata M. Latti, stenographer, $1 200, and Howard H. Stiegerwald, clerk, $1 200. Messrs. Holland, Snow, Freeman, and Singstad are members of the Society.

A board of consulting engineers has been appointed, consisting of J. Vipond Davies, Col. Henry W. Hodge, Col. William J. Wilgus, Maj. John A. Bensel, and Professor William H. Burr, all of whom are members of the Society. Each is to receive a salary of $10 000 a year. Edward A. Byrne, M. Am. Soc. C. E., Chief Engineer of the Department of Plant and Structures, also named as a consulting engineer, will receive no compensation, because of his connection with the City Government.

The duties of the consulting engineers will consist of advising the chief engineer of the Commission, to follow the progress of the work, and to report formally to the Commission every quarter. Regular meetings are to be held by the board every fortnight until the type of tunnel is decided upon, and thereafter at stated intervals. The City of New York has provided office room for the engineers in the Hall of Records.

Labor and Scientific Research

The American Federation of Labor adopted the following resolution at its Atlantic City convention:

"*Whereas,* scientific research and the technical application of results of research form a fundamental basis upon which the development of our industries, manufacturing, agriculture, mining, and others must rest; and

"*Whereas,* the productivity of industry is greatly increased by the technical application of the results of scientific research in physics, chemistry, biology, and geology, in engineering and agriculture, and in the related sciences; and the health and well-being not only of the workers, but of the whole population as well, are dependent upon advances in medicine and sanitation; so that the value of scientific advancement to the welfare of the nation is many times greater than the cost of the necessary research; and

"*Whereas,* the increased productivity of industry resulting from scientific research is a most potent factor in the ever-increasing struggle of the workers to raise their standards of living, and the importance of this factor must steadily increase since there is a limit beyond which the average standard of living of the whole population cannot progress by the usual methods of re-adjustment, which limit can only be raised by research and the utilization of the results of research in industry; and

"*Whereas,* there are numerous important and pressing problems of administration and regulation now faced by Federal, State, and local governments, the wise solution of which depends upon scientific and technical research; and

"*Whereas,* the war has brought home to all the nations engaged in it the overwhelming importance of science and technology to national welfare, whether in war or in peace, and not only is private initiative attempting to organize far-reaching research in these fields on a national scale, but in several countries governmental participation and support of such undertakings are already active; therefore be it

"*Resolved,* by the American Federation of Labor in convention assembled, that a broad programme of scientific and technical research is of major importance to the national welfare and should be fostered in every way by the Federal Government, and that the activities of the Government itself in such research should be adequately and generously supported, in order that the work may be greatly strengthened and extended; and the Secretary of the Federation is instructed to transmit copies of this resolution to the President of the United States, to the President *pro tempore* of the Senate, and to the Speaker of the House of Representatives."

Army Equipment for Highway Work

In addition to the 20 000 army motor trucks that were recently turned over to the Bureau of Public Roads by the War Department, arrangements are now being completed for a large quantity of additional engineering equipment to be distributed by the Bureau of

Public Roads. This equipment is to be furnished to the States without charge, in accordance with recent legislation empowering the Secretary of War to provide military equipment not needed for military purposes but valuable in highway construction work.

The additional equipment will be returned from France as soon as possible. It includes about 1 500 caterpillar tractors; about 400 road rollers, steam and gas driven; and a large number of concrete mixers, road graders, elevating graders, rock crushers, industrial locomotives, industrial railway track, dump cars, steam shovels, hoisting engines, electric motors, and quantities of smaller equipment. In urging the immediate return of this equipment, the Secretary of Agriculture pointed out the fact that the road programme was the biggest scheme in the stage of development for the improvement of the country, for the use of materials that will help to stabilize business along a number of lines, and for the employment of labor, and that because of the rapid expansion of this work, necessary equipment was not otherwise obtainable.

Resolutions on the Death of Homer P. Ritter, M. Am. Soc. C. E.

At a meeting of the Mississippi River Commission on April 23d, 1919, the following resolution on the death of Homer Peter Ritter,* M. Am. Soc. C. E., was presented by J. A. Ockerson, Past-President, Am. Soc. C. E., and carried:

"An All Wise Providence has suddenly called from our midst our friend and associate Homer P. Ritter, and we desire to spread upon the records of the Mississippi River Commission this statement of the deep sorrow which has fallen upon us without warning and expressions of our sympathy for his family with whom we mourn his loss.

"He entered the work of the Commission in 1879 and rendered valuable aid in the physical investigations of the Mississippi River. After serving six years in that capacity he was called to the service of the Coast and Geodetic Survey, where he was still a prominent member of its corps of experts when he came to his untimely end.

"He was appointed a member of the Mississippi River Commission in 1904, and his conscientious devotion to duty was such that although ill he insisted on accompanying the Commission on its inspection trip leaving St. Louis on April 15th, 1919, but on reaching Memphis, April 17th, illness compelled his return to his home in Washington, and he bade us a sad farewell.

"He will linger with us in fond remembrance for his kindly, genial friendship and his good qualities as a valuable Member of the Commission.

"As a matter of respect to his memory, be it resolved that the flag on the steamer *Mississippi* be carried at half mast during the present session of the Commission."

* A memoir of Mr. Ritter was published in May, 1919, *Proceedings*, p. 387.

Business Training for Engineers

A conference, under the auspices of the Bureau of Education, to discuss business training for engineers, was held at Washington, D. C., on June 23d and 24th, 1919. A large number of educational institutions and technical societies were represented by delegates. Francis R. Weller, M. Am. Soc. C. E., represented the American Society of Civil Engineers.

The discussions were participated in by a large number of the delegates and indicated that many colleges are alive to the necessity for revising their engineering courses by the introduction of more business and economic topics in such courses.

The following was adopted unanimously:

"*Resolved,* that it is the sense of the meeting that:

"1. Industrial and commercial development has created a demand for men with technical engineering training and business ability. Manufacturing industries are seeking engineers to qualify to serve in capacities requiring sound business training. Banks and brokers also need men with business training and the engineering point of view. This need is rapidly increasing and bids fair to demand a large number of technically trained men for both domestic and foreign commerce.

"2. In order to meet this demand the economic phases of engineering subjects should be emphasized wherever possible in engineering instruction. This may be done by emphasizing the problems of values and costs in the regular technical work and by introducing or extending courses in general economics, cost accounting, business organization, and business law into the engineering curricula. These courses should be designed particularly to meet the needs of the engineering student.

"3. The engineering phases of economic subjects should be emphasized wherever possible in commercial instruction. Students in commercial courses should also be given opportunity to take special courses in the basic principles and practices of engineering so that they may understand in general terms the operation of power plants and transportation systems from the engineering point of view.

"4. It is also urged upon all institutions with departments in engineering and economics or commerce that they consider some plan of co-ordination to develop a course in preparation for those careers wherein practical training in modern languages, in the essentials of engineering and business theory and practice have been found to be both helpful and necessary."

Recent Activities of Engineering Council

Engineering Council has recommended to President Wilson the appointment of an Engineer as a Member of the International Joint Commission which has authority over the boundary line between the United States and Canada.

In view of the fact that there soon may be a vacancy in the United States Interstate Commerce Commission, Engineering Council has

under consideration a letter to President Wilson recommending the appointment of an Engineer to fill this vacancy when it occurs.

Last Spring, Engineering Council took part in the organization of a National Board for Jurisdictional Awards in the Building Industry. Rudolph P. Miller, M. Am. Soc. C. E., has accepted an appointment as Engineering Council's representative on this Board which will pass upon labor and other questions of vital importance to the building industry.

The Committee on Classification and Compensation of Engineers appointed by Engineering Council is continuing its activities in three important directions—Railways, the National Government, and State and Municipal Governments. Hearings recently have been held before the Director General of Railroads.

Engineering Foundation and the Division of Engineering of National Research Council are co-operating with the University of Illinois on research concerning the phenomena of the fatigue of metals. This work will probably extend over two or three years. Engineering Foundation has offered to contribute $15 000 per year for two years; the University of Illinois will contribute the services of Prof. H. F. Moore, and the use of space, laboratories, etc.; manufacturers have agreed to furnish materials for tests; the Division of Engineering of National Research Council will supply the organization plans and advice as to the lines to be followed in this important research work.

Brief Notes

Worcester R. Warner, President of the Warner and Swasey Company, Cleveland, Ohio, and Charles F. Brush, Electrical Engineer and Inventor, of Cleveland, were elected Honorary Members of the Cleveland Engineering Society on June 10th, 1919.

Carleton E. Davis, M. Am. Soc. C. E., Chief of the Bureau of Water, Philadelphia, Pa., is the new President of the American Water Works Association.

W. J. Powell, M. Am. Soc. C. E., has been honorably discharged as Major, Transportation Corps, A. E. F., and has been appointed County Engineer of Dallas County, Texas, which is just starting a $6 500 000 road project.

According to "Statistical Summary of the War with Germany", a publication prepared by Col. Leonard P. Ayres, U. S. A., of the General Staff, and authorized by the War Department, the war cost the United States $21 850 000 000, or approximately $1 000 000 per hour. The number of men sent overseas was 2 086 000 and of these 1 390 000 saw battle service. The United States armies participated in 13 major

operations. In the Meuse-Argonne Battle, 1 200 000 American soldiers were engaged.

Secretary Glass, of the Treasury Department, has made an estimate that the war cost the United States $30 177 000 000 up to June 30th, 1919, in submitting to the Congressional Appropriation Committees the preliminary statements of the Treasury on the condition of the nation's finances.

In an address before the Union League Club of Philadelphia, Pa., on June 25th, 1919, W. W. Atterbury, M. Am. Soc. C. E., late Brigadier General, U. S. A., and former Director General of Transportation with the American Expeditionary Forces, made a stirring appeal for the immediate establishment of a strong army. In the course of his address, Gen. Atterbury criticized America's lack of preparedness at the time of its entry into the War and, in order to protect the future interests of the United States, suggested the establishment of a National Defense Board.

The resignation of Col. Samuel T. Ansell, former Acting Judge Advocate General, U. S. A., was accepted on July 21st, 1919, by Secretary Baker. Col. Ansell has announced that he will continue his fight for a radical revision of the Army court-martial system.

O. Praeger, Second Assistant Postmaster General, announces that the air mail service will be extended from Chicago to Omaha and St. Louis, next fall, and that experiments are being conducted with a view to making it possible for the mail planes to deliver and receive small bags while in flight.

At the closing session of its Annual Convention, on June 23d, 1919, the American Federation of Labor pledged itself to obtain a general 44-hour week for workers of all crafts throughout the United States, and for employees in Government service.

From the records of the Alcock-Brown Atlantic flight, aeronautic experts state that an airplane capable of carrying 100 000 lb., can be constructed, and that non-stop flights can be made from Atlantic City to England, on the consumption of not more than 1 gal. of gasoline per mile.

A direct waterway connection between Chicago and Liverpool and Hamburg, by way of the Great Lakes and the St. Lawrence River, was inaugurated by the development of operations of the United States Shipping Board, when the all-steel steamship, *Lake Granby,* built in South Chicago, cleared that port on her maiden voyage for Liverpool.

The *Journal of Commerce* states that the general economic position of Denmark has improved so much that the debt of 1 000 000 000 kroner,

owing to foreign countries in 1914, has been transformed into a credit balance of 1 000 000 000.

The State of Arizona and its fourteen counties have started on a road-improvement programme which is expected to consume at least $10 000 000, assisted by National and Forest Service appropriations.

According to figures compiled by the State Highway Department, Texas will spend, in 1919, a total of $76 216 000 on improved highways.

At the Convention of the Western Efficiency Society, in Chicago, Ill., it was stated that 55% of the factories replying to a questionnaire to determine the success of employee representation in factory management, reported that the plan had stimulated production.

Arrangements are being made between the Chinese Government and Japanese bankers for the construction of 200 miles of railroad in Manchuria.

At the request of Mr. Henry Ford, Commissioner of Internal Revenue Roper has instructed the Detroit Branch of the Internal Revenue Bureau to supply Mr. Ford with expert assistance to determine the amount of his share of profits on war contracts. He desires to return such profits to the Government.

It was announced on June 27th, 1919, that the Post Office Department had cleared $17 000 000 for the fiscal year 1918.

A dispatch from Paris states that a bill providing for the nationalization of all the railroads in France was introduced in the Chamber of Deputies on June 26th, 1919, by Albert Thomas, the Socialist leader and former Minister of Munitions.

Oregon has voted a $2 500 000 bond issue contingent on a Federal appropriation of an equal sum, to build the Roosevelt Highway, a military coast road running from Astoria to the California line.

Statistics compiled by the Railroad Administration show that a steady reduction in the number of women employed by railroads is taking place, as the result of the demobilization and return of men to their old jobs. From a high mark of 101 785 women employees, on October 1st, 1918, the number had decreased on April 1st, 1919, to 85 393. The first women to be let go were those engaged in heavy work in the round-houses and shops. In clerical occupations, where 72% of women were used, a small reduction has taken place.

It was announced that, on June 30th, 1919, the War Trade Board became a Division of the State Department, and that the functions and records of the Board were transferred to that Department.

President Wilson, on July 10th, 1919, accepted the resignation of E. N. Hurley, as Chairman of Shipping Board, effective August 1st. It is understood that Mr. Hurley will be succeeded by John Barton Payne, General Counsel of the Railroad Administration.

The proposal to issue $40 000 000 in bonds for the building of highways has been favorably passed on by a vote of the people of California.

The Shipping Board states that schools of naval architecture and ship construction may soon become important branches of the educational institutions of the United States if this nation continues its headway in maritime strength. Fourteen universities and technical colleges have signified their interest in this line of instruction, and some of them have already established courses in Naval Architecture, Marine Engineering, and Ship Construction, while others are planning similar action.

Governor Smith, of New York State, has approved the bill proposing the elimination of adult illiteracy in the State. The new law appropriates $100 000 for the Americanization plan outlined by the State Board of Regents. There are about 600 000 persons in the State who are unable to speak English, and about 350 000 who are unable to read or write any language.

A dispatch from Paris states that, on July 14th, 1919, Minister of Finance Klotz introduced, in the Chamber of Deputies, a bill approving an agreement with a company called "Credit National", organized to facilitate the repair of war damages.

According to statistics made public on July 16th, 1919, by Director General Hines, the railroads of the United States hauled 4 276 949 troops on special and regular trains for an average of 660 miles each in the first six months of 1919.

It is announced that Louisiana will spend $10 000 000 on highways in 1919-20. The Federal Government's allotment to the State so far is $3 741 000. Contracts have also been let by the State of Ohio for highway improvements to cost $3 500 000.

The American Electric Railway Association has issued an endorsement of President Wilson's action in creating a Federal Commission to investigate street railway problems.

A Paris dispatch states that contracts for reconstruction work, aggregating 200 000 000 francs, covering the rebuilding of destroyed areas of Rheims, Nancy, and Soissons, have been awarded to American firms.

The Council of National Defense has compiled a digest of "Foreign Readjustment and Reconstruction," one of "State Readjustment and Reconstruction," and "Readjustment and Reconstruction Bills and Resolutions Introduced in the 65th Congress." By special arrangement with the Council of National Defense, any part of this information is made available to all engineers through Engineering Council's National Service Committee. Complete and recent information is also available on:

Road construction work: National appropriation bills, State appropriations, war material available, comparative United States and foreign programmes, and operations of the committee to carry the work into effect.

N-C flying boats, including their design, dimensions, the purpose for which they are built, their capacity, and performance.

Description of the vocational engineering and apprenticeship courses provided by the Government, and recommendations for their use in the factory.

Description of the Interior Department's educational exposition which covers its engineering work.

According to statistics provided the French Chamber of Commerce of Deputies, by M. Lebrun, Minister of Liberated Territories, there are 550 000 buildings to be rebuilt in devastated districts of France. About 300 000 buildings were totally destroyed, and 250 000 were destroyed in part.

The War Department issues figures showing that for the period from July 1st, 1918, to April 30th, 1919, the average daily expenditures of the Military Establishment were $27 400 000, or more than one-half of the average daily expenditures for all Government purposes.

The United States Shipping Board has appointed Mr. P. A. S. Franklin, of New York City, as chairman of a committee to recommend to Congress such changes in the navigation laws relating to measurement, standardization, and construction inspection, as will place American shipping on approximately the same basis as foreign shipping.

It was announced on May 31st, 1919, that States which have expended large sums in road construction and improvement are assured equitable compensation for their work under the terms of the highway measure introduced in Congress recently by Senator Townsend, incoming Chairman of the Committee on Post Offices and Post Roads.

The Trustees of Cornell University have voted increases in salaries of all members of the Faculty, ranging from 20% to 33%, and also to raise the tuition fee to $200.

L'Intransigeant says it understands that Americans have obtained a concession from China to extend the American-Chinese Railway from its present northern terminus to the Caspian Sea, and states that Americans also intend to build a line from the Caspian Sea to the Black Sea.

In a paper on the use of light railway transportation systems, by C. F. Lang, of Cleveland, Ohio, the contention was made before the Pan-American Commercial Conference that "the light railways in practically all countries in North and South America can be built and maintained with a smaller investment than a well paved highway".

V. L. Havens, M. Am. Soc. C. E., at the Pan-American Conference, called attention to the necessity of a standardized technical vocabulary for engineers, saying that it would facilitate the exchange of engineering equipment and appliances between the Americas.

A company has been established, at Lima, to construct a long-distance telephone system for commercial use in Peru.

According to Dr. A. Lambert, President of the American Medical Association, with the exception of influenza, all epidemics have been eliminated in modern warfare.

Statistics are cited by R. S. Bonsib, Chief of the Division of Safety Engineering, Working Conditions Service, in a bulletin on safety work, to the effect that 88% of the industrial accidents are due to man failure, and are not directly chargeable to machinery at all; and that of 38 000 000 working men and women in the United States, 700 000 each year lose limbs, or are laid up for an average of four weeks each, entailing a monetary loss to wage-earners aggregating $50 000 000.

A 5-day week for brain-workers on the *London Times* has been inaugurated by Lord Northcliffe. It includes editors, copy-readers, and reporters. It is stated that the system shortly is to be extended to the *Daily Mail,* and other publications.

Dr. J. M. Goldstein, Professor of Political Economy of the High Institute of Trade and Economy of the University of Moscow, in a survey of the condition of Russia, issued by the Russian Bureau of Information, New York City, calculates that for 10 years, beginning with the death of Bolshevism, expenditures of $56 450 000 000 will be needed, of which approximately one-half will be furnished by Russia. He states that the restoration of the country, however, depends largely on assistance from the Allies.

H. E. Morgan, of the Civil Service Commission, issued a pamphlet June 16th, 1919, outlining what the United States Government, the largest employer in the world, wants to do for returning soldiers, sailors, and marines. The pamphlet contains a list of numerous kinds of jobs which go to make up the civil service army of the Government.

The invention of a hydrophone which is able to pick up the faintest sound through water at a distance of from 4 to 5 miles, and to show the exact location of the vessel creating the sound, is claimed by J. A. Burgess, formerly Master of Science, Bishop Ridley College, Ontario.

At the Atlantic City Convention, the American Federation of Labor went on record as favoring the restriction of immigration from Europe for a period of three years.

The Senate, on June 21st, 1919, passed the bill of Senator Hoke Smith, providing for the vocational rehabilitation, through Federal aid, of persons injured in industry. Under the proposed law, the Federal Government and the States will co-operate in supplying the funds.

The Office of the Director of Sales announces that the War Department has for sale a surplus of iron and steel, metal scrap, and waste materials, which has accumulated at the manufacturing plants, depots, camps, posts, and arsenals, operated by the respective Bureaus in the United States.

Following a conference at the office of J. P. Morgan and Company, Mr. H. P. Davison has announced the personnel of the Bankers' Committee which is to represent New York financial interests in drafting a comprehensive plan for extending aid to European countries and furnishing markets for American producers, as follows: J. P. Morgan, Chairman, J. S. Alexander, J. S. Brown, A. Forbes, A. W. Kerch, C. H. Sabin, J. H. Schiff, J. Stillman, S. Prosser, and A. H. Wiggin.

Robert A. Cummings, M. Am. Soc. C. E., has accepted the appointment as representative of the American Society of Civil Engineers at the ceremonies in connection with the opening of the new buildings of the United States Bureau of Mines at Pittsburgh, Pa.

At the meeting of the Board of Direction held in Minneapolis, Minn., on June 16th, 1919, the Secretary was instructed to notify the Seattle Association of Members that the Society will be glad to send its *Proceedings* and Year Book to any Local Association which has a regular meeting place, or a place where such files may be consulted.

John H. Delaney, of Brooklyn, N. Y., was named by Governor Smith on May 26th, 1919, as Transit Construction Commissioner for New York City. At the time of his appointment, Mr. Delaney was Commissioner of Plants and Structures for the City of New York.

Baron Rayleigh (John William Strutt), the eminent British physicist, died on June 30th, 1919. He was awarded the Nobel Prize for physics in 1904.

K. M. Boorman, Assoc. M. Am. Soc. C. E., and Harold Perrine, Mem. Am. Soc. for Testing Materials, have formed a professional partnership under the name of Boorman and Perrine, 112 West 42d St., New York City, for the practice of engineering in France and Italy. Mr. Boorman has sailed for France.

Death of Andrew Carnegie

Andrew Carnegie, the iron-master and philanthropist whose generous gift made possible the erection of the United Engineering Societies' Building and the Engineers' Club, in New York City, died of bronchial pneumonia at his summer home at Lenox, Mass., on August 11th, 1919. At a special meeting of the officers of the United Engineering Society and the Presidents and Secretaries of the Founder Societies, held on the afternoon of August 11th, appropriate resolutions on the death of Mr. Carnegie and his benefactions to the Engineering Profession were adopted.

ANNOUNCEMENTS

The Reading Room of the Society is open from 9 A. M. to 10 P. M., every day, except Sundays, New Year's Day, Fourth of July, Labor Day, Thanksgiving Day, and Christmas Day; during July and August, it is closed at 6 P. M.

FUTURE MEETINGS

September 3d, 1919.—8.30 P. M.—This will be a regular business meeting. A paper by Ernest Wilder Clarke, M. Am. Soc. C. E., entitled "Contracts—A Comparison of 'Cost Plus' with Other Forms," will be presented for discussion.

This paper is printed in this number of *Proceedings*.

September 17th, 1919.—8.30 P. M.—The usual meeting will be held on this evening, and announcement of the speaker and subject will be made later.

October 1st, 1919.—8.30 P. M.—A regular business meeting will be held, and a paper entitled "Physiography of Water-Sheds and Channels, and Analysis of Stream Action of Southern California Rivers, with Reference to the Problems of Flood Control", by A. L. Sonderegger, M. Am. Soc. C. E., will be presented for discussion.

This paper is printed in this number of *Proceedings*.

HOW TO MAKE REMITTANCES TO THE SOCIETY

The attention of members is called to the rule* that all remittances should be made payable to the order of the American Society of Civil Engineers. Checks, drafts, money orders, etc., should never be drawn to the order of an individual in payment of a bill from the Society. Observance of the rule will expedite clerical work and prevent avoidable delay in the closure of accounts.

ROLL OF HONOR

Now that the war is over, the monthly publication in *Proceedings* of the Roll of Honor has been discontinued. It is planned to publish later for permanent record a list of all the members of the American Society of Civil Engineers whose names have appeared on this list.

ENGINEERING SOCIETIES EMPLOYMENT BUREAU

Engineering Societies Employment Bureau, established December 1st, 1918, as an activity of Engineering Council, is managed by a board made up of the Secretaries of the four Founder Societies, funds for its maintenance being provided by these Societies. The Bureau already is co-operating with engineering organizations in all parts of the country

* See Year Book, 1919, p. 20.

and with the Professional Section of the United States Employment Bureau. It is desirous of increasing such co-operation by working with local engineering associations and clubs. The work of the Bureau since its inception has been largely in the line of securing employment for men retiring from government war service. Members of the American Society of Civil Engineers who desire to register with this Bureau should apply for further information, registration forms, etc., to Walter V. Brown, Manager, Engineering Societies Employment Bureau, 16th Floor, Engineering Societies Building, 29 West 39th Street, New York City.

SEARCHES IN THE LIBRARY

As the Library of the American Society of Civil Engineers has been merged in the Engineering Societies Library, requests for searches, copies, translations, etc., should be addressed to the Director, Engineering Societies Library, 29 West 39th Street, New York City, who will gladly give information concerning the charges for the various kinds of service. A more comprehensive statement in regard to this matter will be found on page 21 of the Year Book for 1919.

PAPERS AND DISCUSSIONS

Members and others who take part in the oral discussions of the papers presented are urged to revise their remarks promptly. Written communications from those who cannot attend the meetings should be sent in at the earliest possible date after the issue of a paper in *Proceedings*.

All papers accepted by the Publication Committee are classified by the Committee with respect to their availability for discussion at meetings.

Papers which, from their general nature, appear to be of a character suitable for oral discussion will be published as heretofore in *Proceedings*, and set down for presentation to a future meeting of the Society, and, on these, oral discussion, as well as written communications, will be solicited.

All papers which do not come under this heading, that is to say, those which from their mathematical or technical nature, in the opinion of the Committee, are not adapted to oral discussion, will not be scheduled for presentation to any meeting. Such papers will be published in *Proceedings* in the same manner as those which are to be presented at meetings, but written discussions only will be requested for subsequent publication in *Proceedings* and with the paper in the volumes of *Transactions*.

The Board of Direction has adopted rules for the preparation and presentation of papers, which will be found on page 35 of the Year Book for 1919.

LOCAL ASSOCIATIONS OF MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

San Francisco Association, Organized 1905.

E. J. Schneider, President; Nathan A. Bowers, Secretary-Treasurer, 502 Rialto Building, San Francisco, Cal.

The San Francisco Association of Members of the American Society of Civil Engineers holds regular bi-monthly meetings, with banquet, and weekly informal luncheons. The former are held at 6 P. M., at the Engineers' Club, 57 Post Street, on the third Tuesday of February, April, June, August, October, and December, the last being the Annual Meeting of the Association.

Informal luncheons are held at noon, every Wednesday, at the Engineers' Club, where special tables are reserved for members and guests of the Association.

The by-laws of the Association provide for the extension of hospitality to any member of the Society who may be temporarily in San Francisco, and any such member will be gladly welcomed as a guest.

(Abstract of Minutes of Meeting)

April 15th, 1919.—The meeting was called to order at the Engineers' Club; President Schneider in the chair; Nathan A. Bowers, Secretary; and present, also, 84 members and guests.

The guests of the Association were James W. Beebe, Capt., Engineers, U. S. A., Assoc. M. Am. Soc. C. E., in charge of the School of Instruction for Enlisted Men at the Presidio, and Maj. Allen R. Cullimore, Chief of Educational Service, U. S. A. .

Announcements relative to a paper by Maj. W. A. Cattell dealing with the progress of work of the Historical Data Section of the Engineer Corps, U. S. A.; a request from J. C. Whitman, Chief Examiner, California State Civil Service Commission, for the appointment of a committee of the Association to co-operate with the Commission in its work, which request, on motion, duly seconded, was referred to the Public Relations Committee; the change of date to May, 1920, of the General Engineering Congress to be held in Batavia, Java; and communications from Engineering Council in regard to several of its activities, were made by the Secretary. In connection with the last announcement, Mr. C. E. Grunsky was appointed to represent the Association at a conference of members of engineering and architectural societies to be held in Chicago, Ill., in June, 1919, relative to the organization of a National Department of Public Works.

Speaking for the representative of the Association on the Committee on Development, relative to the plan adopted by the Pittsburgh Association, of appointing committees to consider the same subjects as those assigned to sub-committees of the Development Committee, Mr. Edwin Duryea moved the appointment of similar committees by the Association. On motion, duly seconded, on the suggestion of President Schneider, who pointed out that the Association's Committee on Public Relations could handle that phase of the problem to be considered, the appointment of three other committees was made, namely, (1) Technical Activities; (2) Internal Relations and Relations with

Local Associations; and (3) External Relations with the Engineering Profession.

President Schneider subsequently appointed the following members of the Association as members of these Committees:

(1) Messrs. Edwin Duryea, R. A. Beebee, A. J. Cleary, J. M. Howells, and A. V. Saph.

(2) Messrs. C. J. Rhodin, C. P. Bowie, Erle L. Cope, and H. C. Vensano.

(3) Messrs. C. E. Grunsky, F. G. White, A. A. Brown, S. G. Hindes, and Leroy McWethy.

Mr. C. H. Snyder reported for the Committee on Licensing of Engineers that an agreement had been made with the Southern California Association that the Joint Council of San Francisco Engineering Societies would defer action on a bill for licensing engineers for two years and that, in the meantime, an endeavor would be made to unite all engineers of the State on some licensing measure. President Schneider congratulated Mr. Snyder on his work on the Licensing Committee, and moved that he be continued as Chairman of that Committee, which motion, having been duly seconded, was carried unanimously.

(President Schneider is one of a committee of two appointed by the Joint Council of Engineering Societies of San Francisco to represent that body on a Joint Committee to include delegates from all the engineering societies of the State, in the preparation of an Engineers Licensing Bill on which all can agree, to be presented to the next session of the Legislature.)

Mr. F. H. Muhs, reported for the Entertainment Committee that the visit to the Government concrete shipyard on the Oakland Estuary, had been greatly enjoyed by 125 members and guests. Mr. Muhs announced that the next excursion would be to the Mare Island Navy Yard and the date therefor, April 24th, was subsequently agreed upon.

Maj. George L. Dillman, reporting for the Public Relations Committee, stated that the Committee had found the classification under the head of Public Relations, on pages 1118-1119, of the December, 1918, *Proceedings*, "to be remarkably complete and well arranged, with the possible exception of the last subdivision", and recommended that the Association arrange for an evening meeting for a general informal discussion of the subjects outlined.

Secretary Bowers reviewed briefly his recent visit to the engineering organizations of the Northwest and the work that was being accomplished by such organizations.

A paper by W. Lewis Clark, Division Engineer of the State Highway Commission, on "The Development of State Highway Work in California", was presented by the author.

After a brief discussion of experience of the Engineering Department and the policy of the Commission in general by members present, the following resolution, on motion, duly seconded, was adopted:

"*Whereas,* It has been proposed that the State of California authorize a $40 000 000 bond issue for the continuation of the work of the State Highway Commission, therefore be it

"Resolved, That this Association go on record as heartily endorsing the proposed bond issue, and be it further

"Resolved, That a copy of this resolution be sent to the California Highway Commission."

A rising vote of thanks was given to Mr. Clark for his paper.

Adjourned.

Colorado Association, Organized 1908.

W. C. Huntington, President; A. N. Miller, Secretary-Treasurer, 1400 West Colfax Avenue, Denver, Colo.

The meetings of the Colorado Association of Members of the American Society of Civil Engineers (Denver, Colo.) are held on the second Saturday of each month, except July and August. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary. The meetings are usually preceded by an informal dinner. Members of the American Society of Civil Engineers will be welcomed at these meetings.

Weekly luncheons are held on Wednesday at 12.30 P. M., at Daniels and Fisher's.

Visiting members are urged to attend the meetings and luncheons.

(Abstract of Minutes of Meeting)

June 14th, 1919.—The Eleventh Annual Meeting of the Association was called to order at the Shirley Hotel; President L. R. Hinman in the chair; A. N. Miller, Secretary; and present, also, 12 members and 1 guest.

President Hinman read the Annual Address.

The Secretary read a report on matters brought before the Association during the year and also a statement showing its financial condition. On motion, duly seconded, the report was approved and ordered filed.

The Nominating Committee reported the following candidates for officers of the Association for the year 1919-20: For President, W. C. Huntington and E. C. Jansen; for Vice-President, A. E. Palen and Oliver T. Reedy; for Secretary-Treasurer, A. N. Miller.

President Hinman appointed Messrs. Thomas H. Olds and Thomas L. Wilkinson a committee to canvass the ballot for officers, and, after a report from the Committee, declared the following officers elected: President, W. C. Huntington; Vice-President, Oliver T. Reedy; and Secretary-Treasurer, A. N. Miller.

Messrs. Thomas H. Olds and Walter L. Draeger were appointed a Committee to audit the books of the Secretary-Treasurer.

Mr. Wilkinson reported on the status of the Committee on Development.

On motion, duly seconded, a vote of thanks was offered to President Hinman for his efforts in behalf of the Association.

Mr. Arthur O. Ridgway read an abstract of the Constitution of the Colorado Engineering Council, and suggested that the Constitution be printed in the 1919 Year Book.

On motion, duly seconded, the Constitution of the Colorado Engineering Council was ratified, and the Secretary was ordered to pay the dues required.

Mr. E. A. Moritz addressed the meeting on the subject "A Department of Public Works for the Federal Covernment."

Adjourned.

Atlanta Association, Organized 1912.

T. P. Branch, President; J. T. Wardlaw, Secretary-Treasurer, 1530 Healey Bldg., Atlanta, Ga.

Informal luncheons are held for members of the Association on the last Monday of each month, at 12.30 P. M. The place is not fixed, but this information will be furnished on application to the Secretary.

Baltimore Association, Organized 1914.

H. G. Perring, President; Charles J. Tilden, Secretary-Treasurer, The John Hopkins University, Baltimore, Md.

Cleveland Association, Organized 1914.

F. D. Richards, President; George H. Tinker, Secretary-Treasurer, 516 Columbia Building, Cleveland, Ohio.

(Abstract of Minutes of Meeting)

May 31st, 1919.—The meeting was called to order at 12.30 P. M., in the rooms of the Cleveland Engineering Society; President F. D. Richards in the chair; George H. Tinker, Secretary; and present, also, 17 members.

The minutes of the meeting of February 19th, 1919, were read and approved.

Mr. Willard Beahan, Director from this District, reported on the action of the Board of Direction of the Society, at its meeting of April 15th, 1919, in connection with a resolution relative to the Committee on Development submitted by the Association. On motion, duly seconded, it was voted that Mr. Beahan be commended for his action, and requested to continue his efforts for progressive action.

President Richards announced the appointment of Mr. Beahan as alternative for Mr. E. B. Thomas at the meeting of the Committee on Development on June 11th, 1919, inasmuch as Mr. Thomas had stated that he would be unable to attend the meeting.

Mr. J. W. Ellms presented a report from the Committee on Closer Relations with the Cleveland Engineering Society. After discussion, on motion, duly seconded, it was voted that the report be adopted and further action be deferred until the Cleveland Engineering Society had taken action.

The Secretary read communications from the Association of Ohio Technical Societies in relation to the Proposed Engineers' License Bill and a convention of the Ohio Technical Societies. After discussion, on motion, duly seconded, it was voted that the Legislative Committee be instructed to attend such convention when called.

The Secretary read a resolution received from the Kansas Engineering Society and also a "Schedule of Minimum Fees for Civil Engineers" prepared by the Engineers of Mahoning Valley. It was the general opinion of the meeting that the fees were too low, and, on motion, duly seconded, the President was instructed to appoint a committee of three, including himself, to investigate and report on a scale

of wages for civil engineers and to consider the operation of trade unions and their success in improving the conditions of labor.

President Richards read a classified list of members of the Association, prepared at the request of the Publication Committee of the Society, who would assist that Committee in the examination of papers offered for presentation before the Society, and additions were made to the list at the suggestions of members.

The Secretary made a statement relative to the contemplated action of the Cleveland Engineering Society in connection with its Library and proposed new quarters. After discussion of the subject, on motion, duly seconded, the Secretary was instructed to notify the Executive Board of that Society that the Association objects to the consolidation of the Society's Library with any other library or to turning over the operation of it to any other agency.

Adjourned.

Detroit Association, Organized 1916.

T. A. Leisen, President; Clarence W. Hubbell, Secretary, 2348 Penobscot Building, Detroit, Mich.

The regular meetings of the Association are held on the second Friday of December, April, and October, the last being the Annual Meeting.

District of Columbia Association, Organized 1916.

A. P. Davis, President; John C. Hoyt, Secretary-Treasurer, U. S. Geological Survey, Washington, D. C.

Duluth Association, Organized 1917.

G. A. Taylor, President; Walter G. Zimmermann, Secretary, Wolvin Building, Duluth, Minn.

The regular meetings of the Association are held at noon on the third Monday of each month (usually at the Kitchi Gammi Club), with luncheon, followed by a short business session and the reading of papers. Visiting members of the American Society of Civil Engineers can secure from the Secretary definite information relative to the meetings, at which they will be welcomed. The Annual Meeting is held on the third Monday in May.

(Abstract of Minutes of Meetings)

May 19th, 1919.—The meeting was called to order at the Kitchi Gammi Club; President W. B. Patton in the chair; Walter G. Zimmermann, Secretary; and present, also, 26 members and 2 guests.

The reading of the minutes and the regular order of business were suspended, in order to give more time for reports of Committees and plans for the Annual Convention of the Society.

Mr. W. H. Hoyt reported in detail on the Committee meeting held in St. Paul on May 10th, 1919, at which meeting the complete programme for the Annual Convention was laid out. Mr. J. R. Stack, of the Committee on Local Entertainment, stated that he, with the other members of the Committee, Messrs. Pope and Pickles, had spent two days on the Mesabi Range, going over the plans for the trip there with the officers of the Engineers Club of Northern Minnesota, and that

Mr. Maney of the Shenango Furnace Company, had assured the members of the Committee that the representatives of the Mining Companies on the Range would do all in their power to see that the visitors at the Annual Convention were properly taken care of and conducted over the Range.

President Patton announced that, at a meeting of the Board of Directors, he had appointed Messrs. John Carson and W. E. Hawley, a Special Committee on Finances to raise funds for the entertainment of the visitors. The circulation of a subscription list at the meeting resulted in a contribution of $270. Mr. Stack also reported that the Duluth Engineers Club had offered assistance in the matter of finances, and the Committee was instructed to send invitations to all members of that Club to participate in the trip over the Range.

President Patton introduced George C. Newton, Assoc. M. Am. Soc. C. E., representing the Fabricated Ship Corporation, of Milwaukee, Wis., who gave an interesting talk on the subject of "Ship Building."

The following officers were elected for the ensuing year: President, G. A. Taylor; First Vice-President, W. A. Clark; Second Vice-President, J. L. Pickles; Secretary, Walter G. Zimmermann, and Treasurer, John Carson. These officers, with the latest Past-Presidents, namely, Messrs. House and Patton, will constitute the Board of Directors for the coming year.

A rising vote of appreciation for his services as President for the past year was tendered Mr. Patton, and this was followed by a silent toast to the memory of our former members, Messrs. Clarence Coleman and E. Porter Alexander, who had died during the year.

The Auditing Committee, Messrs. Woodbury and Bryan, reported that they had audited the Treasurer's accounts and had found them in proper shape.

Adjourned.

June 16th, 1919.—The meeting was called to order at the Kitchi Gammi Club; President G. A. Taylor in the chair; Walter G. Zimmermann, Secretary; and present, also, 19 members and 1 guest.

The minutes of the previous meeting were read.

Messrs. Pickles and Pope, of the Local Committee on Arrangements for the Annual Convention, reported that practically all the arrangements for the visitors had been made.

President Taylor appointed the following Committees for the ensuing year: Entertainment: Messrs. Lyonel Ayres and J. L. Pickles; Publicity: W. E. Hawley and W. H. Woodbury; Papers and Records: H. C. Ash, J. R. Stack, and O. H. Dickerson; Auditing: George Bryan, Jr., and W. H. Woodbury; Development: W. A. Clark, C. D. Christie, E. K. Coe, and D. A. Reed; Licensing Engineers: D. A. Reed, Leland Clapper, and H. E. McCool; Library: Frank Hutchinson, H. C. Ash, and C. D. Christie.

The Secretary read letters from Messrs. E. R. Lewis and Byron G. Best.

A paper by H. E. McCool entitled, "Cinder Concrete", was read by the author. This paper is to be discussed at the next meeting of the Association.

Adjourned.

Illinois Association, Organized 1916.

H. J. Burt, President; Edgar S. Nethercut, Secretary-Treasurer, 1735 Monadnock Blk., Chicago, Ill.

The regular meetings of the Association are held on the second Monday of March, June, September, and December, the last being the Annual Meeting. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary.

(Abstract of Minutes of Meeting)

July 15th, 1919.—The meeting was called to order at the Chicago Engineers' Club; President H. J. Burt in the chair; E. S. Nethercut, Secretary; and present, also, 37 members and guests.

The President announced the results of the Annual Meeting of the Association, in January, 1919, and explained the omission of other stated meetings.

The President stated that the object of this meeting was "to consider the June report of the Committee on Development," and introduced Mr. Onward Bates, Chairman of that Committee.

Mr. Bates explained briefly the organization of the Committee on Development and the manner of the appointment of its members, reviewed its meetings of November, 1918, and June, 1919, stated the plans for its third meeting, and announced that its final report was to be presented to the Annual Meeting of the Society in January, 1920, calling the attention of members of the Association to the problem as related to Chicago and the relation of the Association to the Western Society of Engineers.

The President announced that the report of the Committee would be taken up, section by section, for discussion by the meeting.

Section (A) "Relations with Other National Societies and Related Organizations", was discussed by E. T. Howson, Secretary of the Committee, who endorsed the recommendation that the Society should continue to pursue the objects for which it was organized as expressed in its Constitution, and the preservation of the identity of the four National Societies.

Mr. Edgar S. Nethercut, representing the Association on the Committee, explained Section (B) "Internal Relations and Local Associations", and emphasized the recommendation of the Committee with regard to the young men of the Profession and engineering students.

Section (C) "Technical Activities", was discussed by Mr. Albert Reichmann, who endorsed the recommendations of the Committee and emphasized the opportunities for committee work, especially in the matter of committees on standardization of practice.

John W. Alvord, Director from District No. 8, spoke on Section (D) "Relation to Public Affairs", emphasizing particularly the importance of the engineer taking his part in public affairs and doing active work in the Society. In regard to the Code of Ethics, Mr. Alvord suggested the appointment in each District of an engineer whose duties would consist in arbitrating differences between engineers, etc.

The subject was discussed generally by Messrs. J. H. Brillhart, William H. Popert, J. H. Prior, Murray Blanchard, A. J. Hammond, J. L. Jacobs, H. C. Phillips and Ralph Modjeski.

The President stated that the subject for discussion at the meeting of September 2d, 1919, would be "The Relation of the American Society of Civil Engineers to Other Societies, National and Local."

Adjourned.

Louisiana Association, Organized 1914.

Arsène Perrilliat, President; Eugene F. Delery, Secretary, 503 City Hall Annex, New Orleans, La.

The regular meetings of the Association are held at The Cabildo, New Orleans, La., on the first Monday of January, April, July, and October.

Nebraska Association, Organized 1917.

*————————, President; Homer V. Knouse, Secretary-Treasurer, 200 City Hall, Omaha, Nebr.

Regular meetings of the Association are held on the first Saturday of each month, except July and August, and at such places as may be appointed from time to time by the Executive Committee. The Annual Meeting is held in Lincoln, Nebr., on the second Friday in January.

Visiting members of the Society are especially urged to communicate with the Secretary when in the city.

Northwestern Association, Organized 1914.

Ralph D. Thomas, President; W. N. Jones, Secretary, City Engineer's Office, City Hall, Minneapolis, Minn.

The meetings of the Association are held bi-monthly, alternating between St. Paul and Minneapolis, on the third Friday of each month. Information as to the time and place of such meetings will be furnished on application to the Secretary.

Philadelphia Association, Organized 1913.

F. Herbert Snow, President; Henry T. Shelley, Secretary, 416 City Hall, Philadelphia, Pa.

The regular meetings of the Association are held at the Engineers' Club of Philadelphia, 1317 Spruce Street, on the first Monday in January, April, and October, the last being the Annual Meeting.

(Abstract of Minutes of Meeting)

June 2d, 1919.—A special meeting of the Association was called to order at 8 P. M., at the Engineers' Club; President F. Herbert Snow in the chair; H. T. Shelley, Secretary; and present, also, 50 members and guests.

The purpose of the meeting was the discussion of the report of the Committee on Public Affairs. This meeting was the last of a series of meetings held monthly since January, 1919, for the purpose of determining the attitude of the members toward the development of the Society, of formulating a definite policy in regard to that undertaking, and to make definite recommendations for the guidance of the local representative on the Committee on Development of the Society. All these meetings were well attended, and the discussions which were entered into very generally, resulted in many definite recommendations.

* Mr. Adna Dobson, the President of the Association, died on May 4th, 1919.

On account of lack of time, several subjects were referred back to the Committees for amplification and further report at a meeting to be held in September. It is the purpose of the Association to continue the work until the whole subject of Development has been covered thoroughly.

At the regular meeting of the Philadelphia Association of Members of the American Society of Civil Engineers held at the Engineers' Club on January 6th, 1919, it was recommended by Mr. Richard L. Humphrey that a meeting of the Association be held in the latter part of January, 1919, or early in February, for the purpose of discussing the work of the Committee on Development. It was voted, at that meeting, that the President appoint a committee to consider the address and discussions of the evening, the address of the President of the American Society of Civil Engineers, and the tentative report of the General Development Committee of the Society, with a view of organizing various committees to be appointed by the President of this Association, to consider specific subjects involved in the addresses, discussions, and report, and to recommend to the Board of Direction such committees and the scope of the work of each, as the committee may deem advisable.

In accordance with this motion, the President appointed the following committees: Committee on Technical Activities; Committee on Internal Relations; Committee on External Relations; Committee on Public Affairs.

These Committees held weekly meetings, and their reports were embodied in the report of the Committee on Development submitted at the special meeting held on February 3d, 1919. The report was taken up for discussion by Committees in the order named, beginning with the report of the Committee on Technical Activities and closing with that of the Committee on Public Affairs.

The reports included recommendations for many changes in the present method of Society procedure and for the greater usefulness of the Society to the individual member as well as to the public. The advisability of more meetings, affiliation with other organizations, co-operation in local, State, and National movements were thoroughly discussed, as were also publications, technical papers, standards, co-operative educational effort, ethics, fees, salaries, publicity, and other subjects.

In order to afford members an opportunity to express their views on the subject of the development of the Society, a printed circular was sent to all members of the American Society of Civil Engineers residing in the Fourth District, eligible for membership in the Philadelphia Association, requesting their participation in the discussions and co-operation in determining final recommendations. The Association, through its committees, has accomplished a great deal in the past year, and as an active programme is being formulated for the coming year, it is hoped that every member of the Society will give the Association the benefit of his services and take an active part in its work.

The next meeting of the Association will be held early in September.

Adjourned.

Pittsburgh Association, Organized 1917.

Robert A. Cummings, President; Nathan Schein, Secretary-Treasurer, 1510 Carson Street, Pittsburgh, Pa.

The Annual Meeting of the Association is held on the first Monday in October. The time and place of other meetings are not fixed, but this information will be furnished on application to the Secretary.

Portland, Ore., Association, Organized 1913.

E. Burslem Thomson, President; C. P. Keyser, Secretary, 318 City Hall, Portland, Ore.

The Annual Meeting of the Association is held on the second Fri day in January. Other meetings are called by the President and are usually convened on Friday evenings. The place is not fixed, but this information may be obtained on application to the Secretary. All members of the American Society of Civil Engineers are cordially invited to attend the meetings.

(Abstract of Minutes of Meetings)

May 16th, 1919.—The meeting was called to order at the University Club at 8 P. M.; President Thomson in the chair; C. P. Keyser, Secretary; and present, also, 13 members.

The Secretary read his letter to Chas. Warren Hunt, Secretary of the Society, and the latter's reply, in the matter of a statement relative to the approval of the Association of the Engineers' Registration Act, in the March, 1919, *Proceedings*, page 304, to which the Association had taken exception. On motion, duly seconded, the Secretary was instructed to reply to Dr. Hunt advising that Roy A. Klein, Assoc. M. Am. Soc. C. E., who furnished the information, is not a member of the Association.

A communication was read from Mr. U. B. Hough, of the Spokane Association, and a member of the Nominating Committee of the Society, the purpose of which was to evoke interest in District No. 12 in the coming election of officers of the Society. On motion, duly seconded, the communication was ordered placed on file. At the suggestion of Mr. J. C. Stevens, who observed that the Association had heretofore neglected to use its influence in this regard, on motion, duly seconded, the following ticket was nominated: For President, Gardner S. Williams; Vice-Presidents, E. C. Carter and Robert A. Cummings; and Director from District No. 12, D. C. Henny.

A communication from Secretary Hunt asking for co-operation with the Publication Committee of the Society in the work of reviewing papers before the Society, was read. On motion, duly seconded, the matter was referred to President Thomson with power.

A letter dated April 28th, 1919, from S. N. Castle, Secretary of an Aims and Objects or Development Meeting, held in New York City, was read and ordered filed.

A letter from J. W. Cunningham, President of the Oregon Society of Engineers, asking that the Association appoint two delegates to consider the coalition of all engineering bodies, was read. On motion, duly seconded, President Thomson and Vice-President Reed were appointed as such delegates, and the Secretary was instructed to advise Mr. Cunningham to that effect.

In the absence of Chairman Hopson, Mr. Reed reported that the Committee on Questionnaire was working on forms and would make a final report at the next meeting of the Association.

On motion, duly seconded, the Secretary was instructed to write to the Governor of the State that, although the Association had opposed the Engineers' Registration Act, it was willing and ready to co-operate, now that it had become a law, in its administration, and to offer assistance in the appointment of the Board of Examiners.

The meeting was addressed informally by B. F. Cresson, Jr., M. Am. Soc. C. E., on the establishment and work of the New York-New Jersey Port and Harbor Development Commission, of which he is Consulting Engineer.

G. H. Binkley, M. Am. Soc. C. E., also addressed the meeting briefly on the attendance, programme, work, etc., of the San Francisco Association.

Adjourned.

June 4th, 1919.—The meeting was called to order at 8 P. M., at the University Club; President Thomson in the chair; C. P. Keyser, Secretary; and present, also, 17 members.

The minutes of the meeting of May 16th, 1919, were read and approved.

Bills for advertising, stationery, etc., were approved and ordered paid.

The Secretary read his letter, addressed to members in other cities in District No. 12, proposing a slate for officers of the Society, together with replies which had been received from members in Boise, Spokane, and Seattle. These replies showed that Boise and Seattle are in complete agreement, Tacoma silent, and Spokane offering a change in the nominee for President. On motion, duly seconded, the Secretary was instructed to reply to members in Spokane accepting their recommendation on the nominee for President, the slate to stand otherwise as originally offered.

The Secretary read his letter to Governor Alcott and the latter's reply, in the matter of the Association's interest in the administration of the Engineers' Registration Law. On motion, duly seconded, it was decided to recommend a slate for members of such Board, chosen from names recommended by the Local Chapter of the American Association of Engineers and the Oregon Society of Engineers, such list to consist, however, only of as many names as there are places on the Board, with the additional statement that the Association does not favor the appointment of men who hold public office.

From the list submitted by the Secretary, the following representatives were nominated and elected: Civil, W. S. Turner, and C. B. McGonigle; Mechanical, Fred M. Hesse and G. A. Covell; Mining, H. M. Parks and R. M. Betts; Hydraulic, E. G. Hopson and J. L. Stannard; and Electrical, O. B. Coldwell, with R. H. Dearborn, as alternate.

Mr. E. G. Hopson presented the report of the Committee on Questionnaire and Individual Register of Local Engineers. On motion, duly seconded, the report was adopted and the Committee thanked for its careful and thorough work.

On motion, duly seconded, a copy of this report was ordered to be sent to the Secretary of Engineering Council and a copy given to Mr. G. C. Mason to present to the Committee on Development.

On motion, duly seconded, the request of Mr. Thomson, Chairman of the Committee on Assistance to the Publication Committee, for the continuance of that Committee was granted.

Mr. Mason, the representative from District No. 12 on the Committee on Development, stated that the Committee would meet in Minneapolis, Minn., prior to the Annual Convention, outlined the present status of its work, and asked for suggestions from members of the Association. On motion, duly seconded, a vote of confidence in Mr. Mason was carried unanimously.

It was suggested that Portland ask for the next Annual Convention, and, on motion, duly seconded, President Thomson was instructed to appoint a committee of one or more members, to get in touch with Mr. Frank Branch Riley and endeavor to have his lecture on "Northwest Scenery" delivered before the Society at the Annual Convention in Minneapolis.

On motion, duly seconded, the Committee on Engineers' Registration or License was discharged.

Adjourned.

June 5th, 1919.—A special meeting of the Association was held at the office of Mr. D. C. Henny; Vice-President Hoffmark in the chair; C. P. Keyser, Secretary; and present, also, 7 members.

The meeting was called by President Thomson to reconsider the action of the meeting of June 4th, 1919, in the matter of the nomination of a candidate for President of the Society.

On motion, duly seconded, the action of the Association of June 4th, concurring with the Spokane Association, was reconsidered, and Mr. Arthur P. Davis was nominated as candidate for President of the Society. This action was unanimous on the part of those present at the meeting, and it was reported, further, that no objection had been raised to Mr. Davis by telephone conference with such members as could be reached, and who were not present at the meeting.

Adjourned.

St. Louis Association, Organized 1888 (Constitution Approved by Board, 1914).

J. A. Ockerson, President; C. W. S. Sammelman, Secretary-Treasurer, 300 City Hall, St. Louis, Mo.

The Annual Meeting of the Association, for the election of officers and for the transaction of business, is held on the fourth Monday in November. Two meetings each year, for the presentation and discussion of technical papers, are held in the Auditorium of the Engineers Club of St. Louis and are open to members of the Associated Societies. Other "get-together" meetings are held regularly for dinner or luncheon on the fourth Monday of each month except July, August, and November.

(Abstract of Minutes of Meeting)

May 26th, 1919.—The meeting was called to order at 1 P. M., at the American Hotel; President Ockerson in the chair; C. W. S. Sammelman, Secretary; and present, also, 21 members and 2 guests.

The minutes of the previous meeting were read and approved.

After discussion of the subject, it was decided, on motion, duly seconded, to give the Programme Committee full power to act in the matter of character and place of meetings.

On motion, duly seconded, it was voted that papers for publication be submitted by the Publication Committee to the Executive Committee of the Association.

Mr. Baxter L. Brown, a member of the Committee on Development, requested that members of the Association assist him by making suggestions, and also presented resolutions adopted by the District of Columbia Association, and by the Ohio, Kansas, and Rochester, N. Y., Engineering Societies.

On motion, duly seconded, the following resolutions of the District of Columbia Association, were approved, No. 1 to be construed in its broadest sense:

"1. *Resolved,* That the Association endorses the idea of a stronger central organization of the engineers of the United States.

"2. *Resolved,* That the Association endorses the idea of a National Department of Public Works, under an eminent engineer to be a member of the Cabinet.

"3. *Resolved,* That the Association endorses the idea that the Annual Meeting of the American Society be composed of delegates of Local Associations or Districts.

"4. *Resolved,* That the Association reaffirms its position of last year, to the effect that the Secretary of the American Society of Civil Engineers should not be a member of the Board of Direction."

The following resolutions adopted by the Ohio, Kansas, and Rochester, N. Y., Engineering Societies, were approved in principle:

"*Whereas,* During the recent world war, the value of the services of professional engineers has become forcefully apparent to and gratefully appreciated by the people of this nation; and

"*Whereas,* It is a well recognized fact that the compensation received by professional engineers, more especially the younger men, has always been low in comparison by trades for services of no greater comparative value; and

"*Whereas,* The need of greater compensation by professional engineers is felt keenly at this time, on account of the recent great advance in the cost of living, and on account of the National recognition of this economic condition in dealing with other professions and trades enjoying proper representation; and

"*Whereas,* The American Society of Civil Engineers, the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the American Institute of Mining Engineers, and the Engineering Council formed by these bodies, seem to have recognized their obligation to professional engineers in matters pertaining to the proper recognition of the value of engineering service;

"Be it Resolved, To appeal to these four great National Societies and their Engineering Council, praying that they, in unity, act in the premises by:

"(1) Providing a practical plan for the registration and proper classification according to character of services of all professional engineers and their assistants.

"(2) Arranging a standard nomenclature to designate the various capacities in which engineers and their assistants serve.

"(3) Adopting, after careful study, a scale of fees and of salaries for the young men of the Profession in such form that it can be used by all local organizations of engineers through the nation in their efforts to secure a fair comparative compensation in accordance with the value of services rendered; and

"(4) Providing a standing committee to co-operate with all organizations of engineers in matters pertaining purely to compensation.

"The Ohio Engineering Society pledges its allegiance and support to the four National Societies in the measure they may develop to supply these urgent needs and essential fundamental requirements for placing the Profession of Engineering on a proper and benefiting plan of industrial equity."

Adjourned.

San Diego Association, Organized 1915.

W. C. Earle, President; R. C. Wueste, Secretary-Treasurer, Bonita, Cal.

Seattle Association, Organized 1913.

L. M. Grant, President; G. A. Collins, Secretary, 1317 L. C. Smith Bldg., Seattle, Wash.

The regular meetings of the Association, with luncheon, are held at the Engineers' Club, Arctic Building, Third Avenue and Cherry Street, at 12.15 P. M., on the last Monday of each month. Informal luncheons are also held at 12.15 P. M., every Monday at the Engineers' Club.

Special evening meetings are held from time to time for the purpose of discussing important topics, and information concerning these meetings may be had by addressing the Secretary. All members in any grade of the American Society of Civil Engineers are cordially invited to attend the meetings when in the vicinity, and, if located in this District for any length of time, their membership in the Association will be appreciated.

Southern California Association, Organized 1914.

George G. Anderson, President; Floyd G. Dessery, Secretary, 511 Central Building, Los Angeles, Cal.

The Southern California Association of Members of the American Society of Civil Engineers (Los Angeles, Cal.) holds regular monthly meetings on the second Wednesday of each month, the December meeting being the Annual Meeting.

Informal luncheons in connection with the Joint Technical Societies of Los Angeles are held at 12.15 P. M., every Thursday at the Broadway Department Store Café.

The by-laws of the Association provide for the extension of hospitality to any member of the Society who may be temporarily in Los Angeles, and any such member will be gladly welcomed as a guest at any of the meetings or luncheons.

(Abstract of Minutes of Meeetings)

May 14th, 1919.—The meeting was called to order at 6.05 P. M., at Christopher's Café; President Anderson in the chair; H. W. Dennis, Secretary, *pro tem.;* and present, also, 24 members and 22 guests.

The reading of the minutes of the previous meeting was dispensed with, as they had already been printed and distributed to the membership.

A letter from Mr. F. E. Trask, Chairman of the Committee on Reconstruction and Development, was read, and in the absence of Mr. Trask, President Anderson explained the efforts of this Committee with particular reference to the re-employment of returned soldiers.

Mr. Burdett Moody, Chairman of the Committee on Co-operation with Federal Bureaus, presented a report from that Committee and a resolution looking to the furtherance of its work with the various Federal Bureaus. Mr. F. D. Bowlus suggested that the United States Department of Agriculture, Irrigation Division, Bureau of Public Roads, be included as a possible source of further information. On motion, duly seconded, the resolution as presented by Mr. Moody was modified to include the suggestion of Mr. Bowlus, and was carried. A vote of thanks was extended to the Committee which was continued.

President Anderson reported on the Committee on Development of the Society, and announced that a meeting of this Committee was called for June 11th, 1919, at Minneapolis, Minn.

The business meeting was then adjourned, and the Association reconvened at dinner. At the conclusion of the dinner, President Anderson introduced the principal guests of the evening, the Hon. W. A. Johnstone, of the California State Water Commission, and the Hon. Jonathan S. Dodge, Chairman of the Los Angeles County Board of Supervisors, both of whom addressed the meeting briefly.

In continuance of the Symposium on the subject of "Flood Control in Southern California", President Anderson read a review, prepared by himself and Mr. W. K. Barnard, of the papers previously presented on the subject, and the discussion was continued by Messrs. W. D. Smith, Samuel Storrow, C. T. Leeds, E. R. Bowen, A. M. Strong, F. D. Bowlus, H. Hawgood, Ford A. Carpenter, H. W. Dennis, and Willis Jones.

Adjourned.

June 11th, 1919.—The meeting was called to order at Christopher's Café at 7.30 P. M.; Vice-President W. K. Barnard in the chair; F. G. Dessery, Secretary; and present, also, 20 members and 8 guests.

The minutes of the meeting of May 14th, 1919, were approved as printed in the Bulletin.

The minutes of the meeting of the Board of Directors held on May 14th, 1919, were read and approved.

F. E. Trask, Chairman of the Committee on Reconstruction and Development, presented an extensive written report showing the progress of the Committee and the efforts made in behalf of returned soldiers. On motion, duly seconded, the report was ordered filed and the Committee continued.

The Secretary announced new members of the Association as follows: Messrs. T. D. Allin, Jay B. Harris, W. W. Orcutt, and C. R. Sumner.

The Secretary read a letter and a resolution received from the Joint Technical Societies, urging Mayor-elect M. P. Snyder to appoint engineers on the personnel of the commissions in the new City Administration.

Chairman Moody and Mr. Morris, of the Committee on Co-operation with Federal Bureaus, reported progress in the work of that Committee and promised an early report.

An invitation was extended to members of the Association by Mr. Franklin Thomas to attend the meeting of the American Society for the Advancement of Science, at Pasadena, Cal.

The Secretary read a telegram from Governor Stephens regretting his inability to attend the meeting.

Vice-President Barnard, of the Programme Committee, outlined the changes in the programme necessitated by reason of the absence of members from the city.

A paper entitled "Check Dams", by Mr. F. H. Olmsted, was presented by the author, and the subject was discussed by Messrs. Warrington, La Rue, Hill, Strong, Ebert, Tait, Willis S. Jones, Sawyer, Bowlus, W. D. Smith, Morris, Barnard, and Pratt.

After a reference to the Conservancy Act, Senate Bill No. 280, which is now a law, Vice-President Barnard introduced its author, Mr. Charles E. Haas, who spoke in detail on Flood Water Acts and Legislation.

The subject of holding meetings of the Association during July and August, was brought up by Vice-President Barnard; it was moved and seconded that meetings during those months be suspended. After discussion by Messrs. Bowen, La Rue, Barnard, and Moody, it was decided to continue the meetings during the next two months.

Adjourned.

July 9th, 1919.—A called meeting of the Association was held at Christopher's Café at 7.30 P. M.; President George G. Anderson in the chair; F. G. Dessery, Secretary; and present, also, 26 members and 13 guests.

The minutes of the meeting of June 11th, 1919, were read and approved. A communication from Dr. Ford A. Carpenter, U. S. Meteorologist, relating to additional data in the daily meteorological reports, was read, and by direction of President Anderson was referred to the Committee on Co-operation with Federal Bureaus, which Committee was directed to give the matter urgent attention.

President Anderson then introduced the speakers of the evening. As a part of the Symposium on Flood Control, Mr. C. E. Tait, Senior Irrigation Engineer, Bureau of Public Roads, U. S. Department of Agriculture, read an interesting and comprehensive paper on "Spreading Flood Waters as Related to Flood Control", and Mr. Willis S.

Jones gave an interesting extemporaneous address on "Spreading Flood Waters as Related to Conservation." The subject matter of these two papers was considered of such importance, that, at the suggestion of Mr. A. L. Sonderegger, it was made the topic of discussion at the next meeting.

Mr. Hawgood, a member of the Board of Direction of the Society, gave an interesting account of the work accomplished by, and the entertainment of members at, the Annual Convention, at Minneapolis and St. Paul, Minn., and paid high tribute to the services performed by President Anderson as a member of the Committee on Development.

President Anderson reviewed, at some length, the work of the Committee on Development and its efforts at the meeting in Minneapolis, Minn., and stated that practically all the changes suggested by the Association had been embodied in its report and that its report, as outlined, is only fundamental of the final report.

Mr. Sonderegger, of the Committee on Co-operation with Federal Bureaus, made a verbal report on the information secured at Washington, D. C., on Engineering Council, and the Secretary read a communication from Mr. M. O. Leighton, Chairman of the Service Committee of Engineering Council.

President Anderson and Mr. Hawgood commented on the efforts of Engineering Council, and it was suggested that members of the Association desiring engineering information take advantage of the offer to that effect contained in Mr. Leighton's letter.

Adjourned.

Spokane Association, Organized 1914.

Harold J. Doolittle, President; Charles E. Davis, Secretary, City Engineer's Office, Spokane, Wash.

The regular meetings of the Association are held on the second Friday of each month, except July and August. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary.

Visiting members are invited to attend the meetings.

Texas Association, Organized 1913.

R. J. Potts, President; J. H. Brillhart, Secretary, Care, Mosher Mfg. Co. Dallas, Tex.

(Abstract of Minutes of Meeetings)

April 25th, 1919.—The meeting was called to order at the St. Anthony Hotel, San Antonio, Tex., at 10 A. M.; President R. J. Potts in the chair; E. W. Robinson, Secretary *pro tem.;* and present, also, 28 members and 12 guests.

The minutes of the meetings of December 13th and 14th, 1918, held in Dallas, Tex., were read and approved.

President Potts read a paper prepared by Mr. J. H. Brillhart who was unable to be present, entitled "Suggested Change for the American Society of Civil Engineers." The paper brought out considerable discussion by those present in regard to the proposed activities of the Committee on Development of the Society.

Mr. J. M. Howe, Chairman of the Legislative Committee, reported on the work of that Committee in its efforts to secure the passage of an Engineers' License Bill through the State Legislature. It is expected that this bill will be passed and become a law at the next session of the Legislature.

Professor F. E. Giesecke presented a paper on "Improving Concrete by Rodding", which was generally discussed.

Adjourned at 12.45 P. M.

The meeting reconvened at 2.30 P. M., with President Potts in the chair; E. W. Robinson, Secretary *pro tem.*

Mr. C. S. Fowler, a member of the State Highway Commission of Texas, addressed the meeting in regard to the work to be undertaken by that Commission. Subsequently, at the request of Mr. Fowler, the following resolution, was, on motion, duly seconded, adopted:

"Resolved, That a special committee of five, be appointed to cooperate with the State Highway Department in regard to the engineering features of highway work in Texas".

President Potts subsequently announced the names of the committee as follows: Messrs. J. F. Witt, Chairman, J. M. Howe, Manton Hannah, J. C. Nagle, and Terrell Bartlett.

Mr. M. C. Irwin, formerly Assistant City Engineer of San Antonio, in charge of sewers, presented a paper entitled "The San Antonio Sewer System." In addition, Mr. Irwin gave a short description of some tests recently made at the plant of the San Antonio Sewer Pipe Works on the strength of culverts constructed of vitrified clay segmental blocks.

Maj. J. B. Hawley addressed the meeting on his work in connection with water supply and sewage disposal in France.

A paper entitled "Effect of Mineral Aggregate on the Life of Bitulithic Pavement", was presented by Mr. Roy M. Green, and illustrated by samples cut from existing pavements in various cities in Texas.

The President addressed the meeting briefly relative to membership in the Texas Association.

Adjourned.

April 26th, 1919.—The meeting reconvened at 10 A. M.; President Potts in the chair; and E. W. Robinson, Secretary *pro tem.*

Twelve men were elected to membership in the Association.

The President read communications from Mr. Brillhart in regard to the work of the Committee on Development of the Society; from George F. Horton, President of the Texas Association of General Contractors, relative to the practice of engineers advertising for the receiving of bids when there is little or no chance of a contract being awarded; from Charles Warren Hunt, Secretary of the Society, in regard to the appointment of a committee to assist the Publication Committee of the Society; and from Mr. F. C. Packard expressing regret at being unable to attend the meeting.

After a short discussion of Secretary Hunt's communication, the President was authorized, on motion, duly seconded, to forward to Mr. Hunt a list of names of members whom he considered to be qualified to co-operate with the Publication Committee of the Society.

After discussion of Mr. Horton's letter, the President was, on motion, duly seconded, authorized to appoint a Resolution Committee. President Potts subsequently appointed the following as such committee: Messrs. J. B. Hawley, Chairman, A. C. Love, and C. N. Black.

The following resolution was presented by the Resolution Committee:

"*Resolved,* that it is the sense of this Association:

"(*a*) That members should decline to assent to advertisement for proposals or other formal solicitation of bids on work unless sufficient funds for construction shall have been provided.

"(*b*) That certified checks accompanying bids should be fixed at reasonable size only.

"(*c*) That all certified checks accompanying bids, excepting that of the successful bidder, be returned upon award of the contract."

Mr. R. G. Upton, of the State Bureau of Sanitary Engineering, addressed the meeting on the work of that Bureau and requested the endorsement of the Association of its work. On motion, duly seconded, the President was authorized to appoint a committee to co-operate with and endorse the general scope of the work of the State Bureau of Sanitary Engineering. The President later announced the appointment of the following committee: Messrs. J. B. Hawley, Chairman, A. J. Wise, and E. W. Robinson.

Capt. J. D. Fauntleroy, District Engineer of the U. S. Office of Public Roads, gave an address on "Federal Co-operation in Highway Construction."

The meeting was addressed by Mr. W. W. Mellen, of the Sinclair Gulf Refining Company, on "Methods and Details of Oil Refining."

On motion, duly seconded, a vote of thanks was extended to Mr. Brillhart for his excellent paper on "Suggested Change for the American Society of Civil Engineers."

Mr. J. A. Dutton, of the Texas Willite Road Construction Company, addressed the meeting on "Roads Constructed under the Willite Patent."

On motion, duly seconded, a vote of thanks was extended to the management of the St. Anthony Hotel for the meeting facilities provided.

On motion, duly seconded, a vote of thanks was also extended to the Local Committee for the arrangements made for the meeting.

Adjourned.

Utah Association, Organized 1916.

A. B. Villadsen, President, 304 Dooly Bldg., Salt Lake City, Utah.

The Annual Meeting of the Association is held on the first Wednesday in April. The time of other meetings is not fixed, but this information will be furnished on application to the President.

PRIVILEGES OF ENGINEERING SOCIETIES EXTENDED TO MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

Members of the American Society of Civil Engineers will be welcome in the Reading Rooms and at the meetings of many engineering societies in all parts of the world. A list of such societies will be found on pages 41 and 42 of the Year Book of the Society for 1919.

NEW BOOKS*

(From May 1st to July 31st, 1919)

The statements made in these notices are taken from the books themselves, and this Society is not reponsible for them.

DONATIONS TO ENGINEERING SOCIETIES LIBRARY

ELECTRICITY AND MAGNETISM FOR ENGINEERS:

Part II, Electrostatics and Alternating Currents. By Harold Pender. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Publishing Co., Ltd., 1919. 221 pp., 172 illus., 9 x 6 in., cloth. $2.00.

The author gives, from an engineering point of view, a description of the more important effects commonly described as electrical and magnetic phenomena, and the application of these laws to some of the simpler problems which arise in connection with the generation, transmission, and utilization of electrical phenomena. The book is intended for college instruction.

MAGNETISM AND APPLICATIONS OF MAGNETS.

By John D. Ball. (School of Practical Electricity, Book 4.) Milwaukee, Electroforce Publishing Co. (copyright 1919). 113 pp., 95 illus., tab., 10 x 7 in., cloth. $1.50. (Gift of Author.)

This volume, which is one of a series of textbooks for technical high schools, trade schools, etc., combines a brief description of the laws and principles of magnetism and the commercial uses of magnets with a selection of laboratory experiments to illustrate the theories of magnetism and electro-magnetism. Only elementary mathematics is used.

CUTTING CENTRAL STATION COSTS:

Ways by Which Central Station Managers, Operating Engineers, and Sales Managers are Meeting High Costs. Compiled by S. B. Williams. N. Y., Published by *Electrical World;* McGraw-Hill Book Co., Inc., Sole Selling Agents, 1919. 322 pp., illus., 9 x 6 in., cloth. $2.00.

The Commercial Editor of the *Electrical World* has here collected the material contributed to that journal during the last nine months of the war, explaining methods adopted by various central stations. Economies in boiler and generating rooms, line construction and distribution methods and substation practice, commercial practice, and administrative plans are discussed.

ELECTRICAL AIDS TO GREATER PRODUCTION:

Plans, Methods, and Appliances by Which Industrial Electrical Engineers are Meeting Increased Demands for Power. Compiled and Edited by Allen M. Perry. N. Y., Published by *Electrical World,* McGraw-Hill Book Company, Inc., 1919. 332 pp., illus., chart, tab., 9 x 6 in., cloth. $2.00.

The Engineering Editor of *Electrical World* has prepared this volume from articles on the application of electricity to plants, which have appeared in that periodical during the last few years. It summarizes the methods that have arisen from the necessity for increased factory output and reduced cost of production, caused by the war, in many classes of industries. Contents: General Power Problems of Industrial Plants; Distribution, Transformation, Switching, and Protection; Motors, Control, Specific Applications, Troubles and Remedies; Illumination—Selection of Equipment, Economies, and Specific Applications; Electric Furnaces, Welding, etc.; Meters and Measurements as Applied to Industries; Handling Material in Industrial Plants with Electric Tractors; Out-door Substations.

*Unless otherwise specified, books in this list have been donated by the publishers.

LABORATORY EXPERIMENTS WITH DIRECT CURRENTS.

By F. E. Austin. [Hanover, N. H., copyright 1917.] 152 pp., illus., 7 x 5 in., flexible cloth. (Gift of Author.)

The subject-matter includes a laboratory course, covering about forty hours, for students in technical and industrial high schools, etc., based on the author's experience as a teacher. The chief aim is to make evident some of the engineering applications of direct currents.

INDUCTION COILS IN THEORY AND PRACTICE.

By F. E. Austin. [Hanover, N. H., copyright 1919.] 64 pp., 45 illus., 9 x 6 in., cloth. $1.00.

This is a presentation of the fundamental principles of the induction coil, for use as a textbook. Intended to enable the student to construct induction coils to meet a variety of demands, as well as to construct coils to fulfill specific requirements.

MARINE INSURANCE:

Its Principles and Practice. By William D. Winter. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Publishing Co., Ltd., 1919. 433 pp., 8 x 6 in., cloth. $3.50.

In this treatise, the writer presents a thorough, simple exposition of marine insurance, suited to the needs of shipping men, merchants, and others who require a general knowledge of the subject. The text is based on a course of lectures given at New York University.

ENGINEERING DESCRIPTIVE GEOMETRY AND DRAWING:

A Treatise on Line Drawing, Descriptive Geometry, and Engineering or Mechanical Drawing, for the Use of Midshipmen at the United States Naval Academy. By Frank W. Bartlett and Theodore W. Johnson. N. Y., John Wiley & Sons, Inc.; Lond., Chapman & Hall, Ltd., 1919. 617 pp., illus., pl., tab., 9 x 6 in., cloth. $5.50.

This volume consists of three independent treatises on Line Drawing, Engineering Descriptive Geometry, and Engineering Drawing. Collectively, they represent the course in drawing at the United States Naval Academy and are intended to provide a complete course for students with no previous knowledge of mechanical drawing. Part 1 has been written to replace Bartlett's "Mechanical Drawing." Part 2, which treats of the science of orthographic projection, was issued as a separate work in 1910, and has been revised to date. Part 3, the work of Professor Johnson, deals with the application of Parts 1 and 2 to the needs of engineers, draftsmen, and mechanics, for practical construction of machines of every kind. Part 3 is also issued separately for the use of those who wish a general course in mechanical drawing.

THE AMERICAN MACHINIST SHOP NOTE BOOK:

A Collection of Articles, Written for the American Machinist by Practical Men, Covering a Wide Variety of Machine Shop Activities and Giving the Solutions of Problems That have Arisen in Machine Shops the World Over. Compiled by E. A. Suverkrop. N. Y., Published by *American Machinist;* McGraw-Hill Book Co., Inc., Sole Selling Agents. 301 pp., 223 illus., 9 x 6 in., cloth. $2.00.

A collection of methods for dealing with difficult or unusual machine-shop jobs, compiled from the periodical mentioned, and classified under the contents to facilitate ready reference. The articles show methods that have been successful and are suggestive to the machinist faced by similar difficulties. Contents: Drafting and Design; Patterns and Foundry; Forge Shop, Hardening and Tempering; Drilling Machine; Engine Lathe; The Milling Machine; Planer and Shaper; Tool Making; Die and Press Work; Gages; Grinding; Boring; Gearing; Screw Machine; Shop Tools, Appliances and Expedients.

BOILER CHEMISTRY AND FEED-WATER SUPPLIES.

By J. H. Paul. Lond. and N. Y., Longmans, Green and Co., 1919. 242 pp., 1 pl., tab., diag., 9 x 6 in., cloth. $4.50.

The lack of any adequate discussion of the chemical reactions which occur in high-pressure boilers fed with natural waters, and of the effects of these reactions on the steaming capacity of the boiler and on the metal of which it is made, have led the author to prepare this volume, in which he gives the knowledge gained by long practical experience with boilers under varied circumstances and conditions. As far as possible, he has stated the facts and his conclusions in the language of every-day life.

EXCAVATION:

Machinery Methods and Costs, Including a Revision of "Excavating Machinery." By Allen Boyer McDaniel. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Publishing Co., Ltd., 1919. 18 + 542 pp., 209 illus., 9 x 6 in., cloth. $5.00.

Frequent requests for information on recent types of excavators and the newer uses of older types, have led the author of this work to prepare it to replace his "Excavating Machinery", published in 1913. The present work is divided into two sections; the first describes the construction, method and typical cost of operation of each type of excavator, the second is a comparative study of the efficient and economic use of the different types of machines in the various fields of construction work. Highway and railroad construction, reclamation, river, harbor, canal and municipal work, quarrying, tunneling, and mining are considered. References to the literature are included.

LIQUID FUELS FOR INTERNAL COMBUSTION ENGINES:

A Practical Treatise for Engineers and Chemists. By Harold Moore. N. Y., D. Van Nostrand Co., 1918. 15 + 200 pp., 49 illus., tab., 9 x 6 in., cloth. $5.00.

The author describes in Part 1 of this volume the chemical differences between the various fuels, petroleum, shale oil, coal and lignite tars, wood and peat distillation products, oils and alcohols, which are used for internal combustion engines. In Part 2, these fuels are classified according to their suitability for use in engines fitted with carbureters, vaporizers, or atomizers. Part 3, presents methods for the examination and valuation of liquid fuels, with a view to their use in these engines, the procedure in such cases being different from that used in determining their value for external combustion.

MOTOR VEHICLE ENGINEERING:

Engines (For Automobiles, Trucks, and Tractors). By Ethelbert Favary. N. Y., McGraw-Hill Book Company, Inc.; Lond., Hill Publishing Co., Ltd., 1919. 12 + 333 pp., 133 illus., 39 tab., 9 x 6 in., cloth. $3.00.

The present volume, the first of a contemplated series intended to give designers, engineers, and students a concise summary of modern practice in automobile design and construction, deals with engines. It illustrates standard designs for all engine parts and gives the formulas for determining the strength and dimensions of these parts, together with other useful information. Only simple mathematics is used.

PUMPING MACHINERY:

A Treatise on the History, Design, Construction, and Operation of Various Forms of Pumps. By Arthur M. Greene, Jr. 2d Edition, Revised. N. Y., John Wiley & Sons, Inc.; Lond., Chapman & Hall, Ltd., 1919. 703 pp., 504 illus., tab., 9 x 6 in., cloth. $4.00.

Gives a brief, historical review of the development of pumping machinery, describes the action of a number of common forms of pumps and states the methods of design of pumping apparatus. It is intended to develop certain general principles of mechanics which are applicable to pumping machinery, as well as to train the student in application of the theoretical portions of an engineering course. The descriptive chapters on modern pumps have been prepared from the catalogues and bulletins of manufacturers and from current technical literature. A full bibliography is included.

AIRPLANE DESIGN AND CONSTRUCTION.

By Ottorino Pomilio. N. Y., McGraw-Hill Book Company, Inc.; Lond., Hill Publishing Company, Ltd., 1919. 403 pp., 248 illus., 58 tab., 9 x 6 in., cloth. $5.00.

A book on the structure and design of airplanes, in which the results of European experimental research in aero-dynamics are presented in considerable detail. The problems relating to airplane design and operation are analyzed, working formulas are derived, and the data needed by designers are presented.

ABRASIVES AND ABRASIVE WHEELS:

Their Nature, Manufacture, and Use; A Complete Treatise on the Manufacture and Practical Use of Abrasives, Abrasive Wheels, and Grinding Operations. By Fred B. Jacobs. N. Y., The Norman W. Henley Publishing Co., 1919. 338 pp., 174 illus., 1 por., 8 x 5 in., cloth. $3.00.

This work opens with descriptions of the various natural and artificial abrasives, the manufacture of grinding wheels and artificial sharpening stones, the grades established in commerce, and the methods of testing grinding wheels. Chapters follow on the care of wheels, dust collecting systems and safeguards, abrasive papers and cloths, methods of surface, cylindrical, and internal grinding, special grinding operations, and cutter and saw sharpening. The author writes from experience as a machinist and as a salesman of grinding wheels.

PRACTICAL SHELL FORGING

And the Plastic Deformation of Steel and Its Heat Treatment. By Clifford O. Bower. N. Y., Longmans, Green & Co., 1919. 279 pp., 152 illus., 4 pl., 17 tables, 10 x 6 in., cloth. $10.50.

This volume, by an experienced British forge master, is a detailed account of the processes of shell manufacture, in which particular attention is given to the laws governing the plastic deformation of steel at high temperatures and the variations in its physical character to be obtained by thermal treatment. It will be useful indirectly, the author hopes, to all persons engaged in the manufacture of hydraulic forgings.

MILITARY GEOLOGY AND TOPOGRAPHY:

A Presentation of Certain Phases of Geology, Geography, and Topography for Military Purposes. Herbert E. Gregory, Editor. Prepared and Issued under the Auspices of the Division of Geology and Geography, National Research Council. New Haven, Yale University Press, 1918. 281 pp., illus., pl., maps, 9 x 6 in., cloth. $1.25.

This book is the result of a preliminary effort to meet the need which the Great War has demonstrated for a more widely diffused knowledge of geology as an aid in conducting military operations and in the solution of economic problems relating to raw materials. Attention is given mainly to those facts and principles that have proven to be applicable to military problems. Bibliographies for supplementary reference study are included.

THE CANADIAN MINING MANUAL, 1918:

A Handbook of Information Concerning the Minerals and Mines of Canada. Edited by Reginald E. Hore. Toronto, Mines Publishing Co. (copyright 1919). 352 pp., illus., pl., por., maps, tab., diag., 11 x 9 in., cloth. $5.00.

This is the fourth edition of this handbook of Canadian minerals, metals, mining, and metallurgical companies, in which the chief objects are to present concisely matters of interest to persons connected with the mining industry and to attract attention to the possibilities of Canadian mineral resources. A preliminary survey of progress in 1918 and a summary of the official reports for 1917 are given for each province and product. There are also a number of special articles on topics of interest, a directory of mining companies, and a list of the producers of various mine products.

STANDARDIZATION OF MINING METHODS.

By Charles A. Mitke. A Series of Important Articles Reprinted from *Engineering and Mining Journal.* N. Y., Published by *Engineering and Mining Journal,* McGraw-Hill Book Co., Inc., 1919. 110 pp., 47 illus., 6 charts, 4 tab., 7 x 5 in., cloth. $1.50.

As mining engineer for the Phelps Dodge Corporation, the author has studied mining practices in detail, with a view to the establishment of standard methods. The present volume is based on his experience and is an account of the standardization of various mining practices in the interests of safety and economy.

MINERAL DEPOSITS.

By Waldemar Lindgren, 2d Edition. N. Y., McGraw-Hill Book Company; Lond., Hill Publishing Co., Ltd., 1919. 957 pp., illus., tab., 9 x 6 in., cloth. $5.00.

Mineral deposits are usually classified and described by the metals or substances which they contain; for instance, deposits of copper are described together, with little or no effort to separate them into genetic groups. This book is the outcome of a desire to place the knowledge of mineral deposits on the broader and more comprehensive basis of a consistent genetic classification, and thus bring it into a more worthy position as an important branch of geology. In this second edition, all the chapters have been revised and several have been largely rewritten. A discussion of metallogenetic epochs has been added, as well as an index by elements. Some less essential descriptions have been excised, in order that the book might not increase in bulk.

MATHEMATICS FOR ENGINEERS:

Part I, Including Elementary and Higher Algebra, Mensuration and Graphs, and Plane Trigonometry. By W. N. Rose. (The Directly-Useful Technical Series.) N. Y., E. P. Dutton & Co. (1919). 510 pp., 257 illus., 11 tab., 9 x 6 in., cloth. $5.00.

This treatise endeavors to cover all the mathematical work needed by students and engineers in their practice, and is intended also to serve as a reference book for private study. Part I deals with the fundamental rules and processes of Algebra, Plane Trigonometry, Mensuration, and Graphs. Practical applications having a direct bearing on engineering practice are added in the greater number of instances, and many calculations, tables, and charts, designed to make the book of the greatest possible assistance to busy engineers, are included.

JAMES WOODHOUSE, A PIONEER IN CHEMISTRY, 1770-1809.

By Edgar F. Smith. Phila., The John C. Winston Co., 1918. 299 pp., 1 pl., 1 por., 8 x 5 in., cloth. $1.50.

Dr. Smith's account of the life and labors of James Woodhouse is a valuable contribution to the early history of chemistry in America. Woodhouse was elected Professor of Chemistry at the University of Pennsylvania in 1795 and retained this connection until his death in 1809. He was an industrious and ingenious chemist, who by his work and writings did much to establish the teaching of chemistry on a sound basis and to arouse interest in the industrial applications of the science.

THE APPLICATIONS OF ELECTROLYSIS IN CHEMICAL INDUSTRY.

By Arthur J. Hale. (Monographs on Industrial Chemistry.) Lond. and N. Y., Longmans, Green and Co., 1918. 148 pp., 56 illus., 9 x 6 in., cloth. $2.50.

The author describes briefly the electrolytic refining and winning of metals, the production of hydrogen and oxygen, chlorin, caustic soda, hypochlorites, chlorates and perchlorates, and of various other organic and inorganic compounds. References to the literature and patents are included.

A SYSTEM OF PHYSICAL CHEMISTRY.

By William C. McC. Lewis. 2d Edition. N. Y. and Lond., Longmans, Green and Co., 1918. 3 vol., diagrams, 9 x 6 in., cloth. $4.50.

Professor Lewis' work is intended as a general textbook for use by those who already possess some knowledge of both physics and chemistry and as a fairly comprehensive account of our present knowledge of the subject. It is well equipped with references to the original literature, and, therefore, is useful for reference use. A third volume, on the Quantum theory, has been added in this edition. Other changes, necessitated by the advances made since the previous edition, have caused considerable expansion of the book.

AN INTRODUCTION TO THE PHYSICS AND CHEMISTRY OF COLLOIDS.

By Emil Hatschek. 3d Edition. Phila., P. Blakiston's Son and Co., 1919. 116 pp., 17 illus., 7 x 5 in., cloth. $1.50.

This small volume is intended to introduce readers with a reasonable knowledge of physics and chemistry, to the fundamental facts and methods of this important branch of physical chemistry. Small additions and corrections have been made to this edition, to include such recent advances as fall within the scope of a brief introductory work.

A CENTURY OF SCIENCE IN AMERICA:

With Special Reference to the *American Journal of Science,* 1818-1918. By Edward Salisbury Dana and others. New Haven, Yale University Press, 1918. 458 pp., 22 por., 9 x 6 in., cloth. $4.00.

The present book commemorates the 100th anniversary of the founding of the *American Journal of Science* by Benjamin Silliman, in July, 1818. The opening chapter gives a somewhat detailed account of the early days of the *Journal,* with a sketch of its subsequent history. The remaining chapters are devoted to the principal branches of science which have been prominent in the pages of the *Journal,* namely, geology, paleontology, mineralogy, chemistry, physics, zoology, and botany. These chapters have been written with a view to showing in each case the position of the science in 1818 and the general progress made during the century. Special prominence is given to American science, and, particularly, to the contributions to it to be found in the pages of the *Journal.*

THE TURNOVER OF FACTORY LABOR.

By Sumner H. Slichter. With an Introduction by John R. Commons. N. Y. and Lond., D. Appleton & Co., 1919. 460 pp., tables, 8 x 5 in., cloth. $3.00.

The author intends this volume to be a comprehensive study of methods of handling men, to supplement existing books on works management. It is founded on personal experience in large industrial plants, visits to factories, talks with employers and workingmen, schedules, and questionnaires. As the study was begun in 1913, and most of the data were collected before the acute situation of 1916, the discussion is from the standpoint of the situation in peace times. The book deals with manual laborers generally, except out-of-door seasonal workers. Contents: General Analysis of the Turnover; The Cost of the Turnover; The Causes of the Turnover; Methods of Reducing the Turnover.

THE BLIND:

Their Condition and the Work Being Done for Them in the United States. By Harry Best. N. Y., The Macmillan Co., 1919. 17 + 763 pp., illus., tab., 8 x 6 in., cloth. $4.00.

The particular sections of this comprehensive survey likely to interest engineers are those treating of the industrial employment of the blind and of indemnities for the loss of sight. Both topics are given full consideration. Attention is given to the theoretical aspects of industrial establishments for the blind, the organization and results of present establishments, and the possible and present employment of the blind in general occupations. The payment of indemnities through suits at law, insurance policies, and workingmen's compensation acts is also described very fully.

MacRAE'S BLUE BOOK.

Chic. and N. Y., MacRae's Blue Book Co., 1919. 1846 pp., 12 x 9 in., cloth. $10.00.

This record of manufacturers is intended for use by purchasing agents interested in iron and steel products, building materials, railway supplies, etc. It includes an alphabetical address list of the principal manufacturers in the United States, a classified index of the makers of 10 000 products, an index of trade names, a collection of miscellaneous data useful to purchasers and users of the articles considered, and the standard list prices of building materials, iron and steel products, etc.

EFFICIENT RAILWAY OPERATION.

By Henry S. Haines. N. Y., The Macmillan Co., 1919. 709 pp., tab., 9 x 6 in., cloth. $4.50.

This volume is a description of the progressive development of efficiency in the operation of the railway system in the United States, as compared with similar progress in other countries, for the use of students, railway employees, and general readers. Railway operation, as distinguished from administration, is the subject of the book; matters of finance, rates, and labor questions, therefore, are not included. A bibliography and extensive statistical tables are given in the appendixes.

TRAINING FOR THE ELECTRIC RAILWAY BUSINESS.

Written Under the Supervision of T. E. Mitten, by B. B. Fairchild, Jr. Phila. and Lond., J. B. Lippincott Co., 1919. 155 pp., 9 pl., 3 charts, 8 x 5 in., cloth. $1.50.

Explains in non-technical language the business side of electric railroading, and gives an insight into the requirements, the opportunities, and the training involved in the several departments. The various engineering and transportation problems are taken up, and the recruiting and management of the army of laborers needed thoroughly discussed.

PRACTICAL HELPS FOR THE ELECTRIC RAILWAY SHOP.

Track, Power, Line, and Rolling Stock Departments. Compiled from the Mechanical and Engineering Edition of *Electric Railway Journal*. N. Y., published by *Electric Railway Journal*, McGraw-Hill Book Company, Inc., 1919. 331 pp., illus., tab., 9 x 6 in., cloth. $2.00.

These extended articles have been selected from a series published in the *Electric Railway Journal*, which was prepared for the information of men responsible for the upkeep of the physical equipment of an electric railway system. The articles cover the fundamentals of the various subjects in a broad, practical manner. Contents: Track and Structures, by R. C. Cram; Power Generation, by Hartley LeH. Smith; Power Transmission, by Charles R. Harte; Car Design, by Norman Litchfield; Car Equipment, by C. W. Squier.

HANDBOOK FOR HIGHWAY ENGINEERS:

Containing Information Ordinarily Used in the Design and Construction of Rural Highways. By Wilson G. Harger and Edmund A. Bonney. 3d Edition, Entirely Revised. N. Y., McGraw-Hill Book Co.; Lond., Hill Publishing Co., Ltd., 1919. 986 pp., illus., tab., 1 map, 7 x 4 in., flexible cloth. $4.00.

This handbook is a compact volume, presenting in convenient form the information ordinarily required in the field and office practice of road design and construction, and is planned to meet the requirements of both experienced and inexperienced road men. In the present edition, approximately 350 pages of new material have been incorporated, covering mountain road location and design, camp equipment, medical notes, photography, selected soil and gravel treatment of moderate traffic roads, and the recent developments of hard surface roads.

TIMBER: ITS STRENGTH, SEASONING, AND GRADING.

By Harold S. Betts. N. Y., McGraw-Hill Book Company, Inc.; Lond., Hill Publishing Company, 1919. 234 pp., illus., maps, charts, tab., 9 x 6 in., cloth. $3.00.

This volume, for engineers, manufacturers, and users of lumber and wood material, is intended to meet the lack of a work on wood as a structural material, similar to existing handbooks on steel, concrete, etc. The methods of testing the strength of wood and wood products, such as telephone poles, packing boxes, and vehicle parts, are described, and the results of numerous tests by the Forest Service are tabulated. A table based on 130 000 tests, showing the average mechanical properties of 124 American woods, is given. Proper methods of seasoning wood are fully discussed. The grading rules of the different Manufacturers' Associations are given, and the book closes with extensive statistics on the lumber produced and used in the United States.

THE ELEMENTS OF ASTRONOMY FOR SURVEYORS.

By R. W. Chapman. Lond., Charles Griffin and Company, Ltd.; Phila., J. B. Lippincott Co., 1919. 247 pp., tab., 56 diag., 8 x 6 in., cloth. $1.75. (Gift of J. B. Lippincott Co.)

The author of this small volume has attempted to provide students of surveying with an elementary exposition, not only of the practical methods of observation and computation, but also of the main principles by which the formulas are derived. The methods of observation are illustrated by fully worked out actual observations, and prominent attention is given to the effects of observational and instrumental errors.

SHORE PROCESSES AND SHORE LINE DEVELOPMENT.

By Douglas Wilson Johnson. N. Y., John Wiley and Sons, Inc.; Lond., Chapman & Hall, Ltd., 1919. 17+584 pp., 149 illus., 73 pl., 9 x 6 in., cloth. $5.00.

Professor Johnson has recorded in compact form the result of an extended study of the scattered literature on shore processes and shore line forms. Water waves, the work of waves, current action, the development of the shore profile and the shore line, shore ridges, and minor shore forms are discussed, and a statement of the fundamental principles which seem best established, is given. The author hopes that the book will prove useful to engineers, geologists, and geographers. Full lists of references and a bibliography are included.

DONATIONS TO THE READING ROOM

FOWLER'S ELECTRICAL ENGINEER'S POCKET BOOK, 1919.

Edited by William H. Fowler. 19th Annual Edition. Manchester, England, Scientific Publishing Company, 1919. 46+512 pp., illus., tab., 6 x 4 in., cloth. 3 shillings 4 pence.

This book, it is stated, contains exhaustive information on electrical engineering rules, as well as tables and data on electrical units, magnets, and magnetism, physical properties of metals, conductors, insulating materials, electric lighting and welding, comparison and measurement of resistances, testing sets, electrical measuring instruments and meters, primary and secondary batteries, dynamos and motors, electric currents, etc., etc.

FOWLER'S MECHANICS' AND MACHINISTS' POCKET BOOK, 1919.

Edited by William H. Fowler. 11th Annual Edition. Manchester, England, Scientific Publishing Co., 1919. 46+464 pp., illus., tab., 6 x 4 in., cloth. 2 shillings 9 pence.

In a secondary title, it is stated that this book is a synopsis of practical rules for fitters, turners, millwrights, erectors, pattern-makers, foundrymen, draftsmen, apprentices, and students, on machine tool design, metal cutting tools, milling cutters, high-speed tool steels, drilling and boring metals, screw-threads, screw cutting and taper turning, precision grinding, shop practice, etc., etc.

FOWLER'S MECHANICAL ENGINEER'S POCKET BOOK, 1919.

Edited by William H. Fowler. 21st Annual Edition. Manchester, England, Scientific Publishing Co., 1919. 62+576 pp., illus., tab., 6 x 4 in., cloth. 3 shillings 4 pence.

This small volume, it is stated, contains nearly 600 pages of rules, tables, and data for mechanical engineers, power users, engine attendants, draftsmen, students, etc., on steam boilers, steam engines, design of valves and gears, locomotives, steam turbines, gas and oil engines, gases used in gas engines, rope and belt driving, wheel gearing, ball and roller bearings, lubrication, proportions of spiral and plate springs, hydraulics, etc., etc.

THE CIVIL ENGINEER'S POCKET-BOOK.

By John C. Trautwine. Revised by John C. Trautwine, Jr., and John C. Trautwine, 3d. 20th Edition. Phila., Trautwine Company, 1919. 1528 pp., illus., tab., 7 x 4 in., flexible cloth. $6.00.

In preparation for this edition of this well-known pocket-book for civil engineers, the original of which was first published in 1872, the compilers, have confined themselves, except for radical and important improvements in the arrangement of several articles and the correction of all known errors in the text, to the modernization and extension of certain railroad subjects and the introduction of entirely new matter on others, the new matter approximating about 400 pages. The rules relating to the Ellipse also have been modernized, extended, and rewritten, a new Isogonic Chart is given, and the Table of Azimuths of Polaris has been revised to cover present dates.

MEMBERSHIP

(From May 9th to August 7th, 1919.)

ADDITIONS

MEMBERS		Date of Membership.
Baillie, Frank Seymour. Office Mgr., Grant Smith Porter Ship Co., Hotel Portland, Portland, Ore.		May 12, 1919
Barrett, Robert Edward. Constr. Engr., Turners Falls Power & Elec. Co.; Gen. Mgr. and Chf. Engr., Connecticut River Conservation Co. (Res., 12 Marshall St.), Turners Falls, Mass.	Jun. Assoc. M. M.	Jan. 31, 1905 Dec. 6, 1910 June 16, 1919
Bishop, Lyman Edgar. Civ., Hydr., and Irrig. Engr., 1213 First National Bank Bldg., Denver, Colo.	Jun. Assoc. M. M.	May 4, 1909 Oct. 31, 1911 June 16, 1919
Buckbee, Neil Stanley. Engr. and Dist. Mgr., Corrugated Bar Co., 537 Woodlawn Ave., Buffalo, N. Y.		June 16, 1919
Bumsted, Eugene Bradford. Cons. Engr., 908 Insurance Exchange Bldg., San Francisco, Cal.	Jun. Assoc. M. M.	May 1, 1900 Mar. 6, 1907 June 16, 1919
Caldwell, Fred Edward. 67 Midland Ave., East Orange, N. J.	Jun. Assoc. M. M.	April 3, 1906 Feb. 1, 1910 May 12, 1919
Carter, Edward Fairbank. Mgr. and Chf. Engr., John S. Metcalf Co., Ltd., National Mutual Bldg., Melbourne, Victoria, Australia		Mar. 11, 1919
Charton, Pierre. Cons. Engr., 516 Transportation Bldg., Montreal, Que., Canada		May 12, 1919
Chittenden, Albert Frederick. Capt., Engrs., U. S. A., 4106 Burke Ave., Seattle, Wash.	Assoc. M. M.	Mar. 14, 1916 April 14, 1919
Cornell, John Wesley. Capt., Q. M. C., U. S. A., 411½ Columbia Rd., Washington, D. C.	Assoc. M. M.	June 30, 1910 June 16, 1919
Dennis, Walter. Maj., Q. M. C., U. S. A., Constr. Div., Moberly, Mo.		June 16, 1919
Farris, John. Pres. and Gen. Mgr., Farris Eng. Co., Empire Bldg., Pittsburgh, Pa.	Assoc. M. M.	Aug. 31, 1915 May 12, 1919
Fichthorn, Joseph Hoover. Chf. Engr., Lewis F. Shoemaker & Co., Pottstown, Pa.		June 16, 1919
Fitch, Josiah Huntington. Engr. in Chg., Eng. Bureau, Dept. of Street Impvts., Borough of The Bronx, 2440 Devoe Terrace, New York City		May 12, 1919
Flick, John Kramer. Engr. and Contr. (Farmer & Flick), 15 East Fayette St. (Res., 2611 Guilford Ave.), Baltimore, Md.	Jun. Assoc. M. M.	Jan. 31, 1911 July 2, 1913 June 16, 1919

MEMBERS (*Continued*)

		Date of Membership.
GILMAN, CHARLES EDWARD. Civ. and Min. Engr. (Duryea, Haehl & Gilman), 1314 Humboldt Bank Bldg., San Francisco, Cal.	Jun.	Oct. 6, 1903
	Assoc. M.	Dec. 5, 1906
	M.	June 16, 1919
GRIER, ARTHUR JAY. Contr. Engr., 480 Chetwood St., Oakland, Cal.		June 16, 1919
GUNBY, FRANK MCCLELLAN. With Charles T. Main, 201 Devonshire St., Boston, Mass.		May 12, 1919
HALL, SAMUEL PRESCOTT. (Allen & Hall), 36 Winner Ave., Columbus, Ohio		Jan. 13, 1919
HAND, GEORGE TROWBRIDGE. Chf. Engr., Lehigh Val. R. R., 475 Vose Ave., South Orange, N. J.		May 12, 1919
HARKNESS, ANDREW HARKNESS. Cons. Engr., 239 Confederation Life Bldg., Toronto, Ont., Canada		June 16, 1919
HAYDEN, FRANK DEMETRIUS. Asst. Prof. of Railroad Eng., Univ. of Washington, 1906 East 65th St., Seattle, Wash.	Assoc. M.	May 31, 1916
	M.	May 12, 1919
HAYDOCK, WINTERS. Capt., Ord., U. S. A., 3119 Thirteenth St., N. W., Washington, D. C.		May 12, 1919
HEALEY, CHARLES FRANK. Engr. of Contracts, Bureau of Eng., Dept. of Public Works, 402 City Hall, Chicago, Ill.	Assoc. M.	June 30, 1910
	M.	Oct. 9, 1917
HEISER, ALFRED BRACKENRIDGE. Engr., Turner Constr. Co., 244 Madison Ave., New York City (Res., 26 Seventy-first St., Brooklyn, N. Y.)	Jun.	Nov. 1, 1910
	Assoc. M.	June 24, 1914
	M.	June 16, 1919
HENNEBIQUE, JULES JOSEPH. Pres. and Chf. Cons. Engr., Case Coast Protection Corporation, 1170 Broadway, New York City		May 12, 1919
HESS, JOHN STRIDER. Chf. Engr., Sinclair Refining Co., 923 Conway Bldg., Chicago, Ill.	Jun.	Oct. 5, 1909
	Assoc. M.	July 2, 1913
	M.	June 16, 1919
HODGDON, BENJAMIN ALEXANDER. Section Engr. in Chg. of Section 5, Routes 4 and 36, Dual Subway System, New York City, 24 Rutledge Ave., East Orange, N. J.	Assoc. M.	Mar. 2, 1909
	M.	Jan. 14, 1919
IBARGÜEN Y PI, ALBERTO ANGEL. Chf. Engr., Dist. of Pinar del Rio, Dept. of Public Works, Marti 51, Pinar del Rio, Cuba	Assoc. M.	June 23, 1916
	M.	June 16, 1919
JACOBS, ROBERT HYDE. Div. Engr. of Tracks, Public Service Comm., First Dist., 49 Lafayette St., New York City	Assoc. M.	May 4, 1904
	M.	June 16, 1919
JOHNSON, JOHN MONROE. Marion, S. C.	Assoc. M.	Nov. 27, 1917
	M.	June 16, 1919

MEMBERS (*Continued*)

		Date of Membership.
JUNKERSFELD, PETER. 147 Milk St., Boston, Mass.		June 16, 1919
KASSEBAUM, FREDERICK WILLIAM, JR. Engr. of Constr., Baltimore Dry Docks & Shipbuilding Co., East Fort Ave., Baltimore, Md.	Assoc. M. M.	April 2, 1912 May 12, 1919
KELLY, EDWARD JOSEPH. Asst. Chf. Engr., San Dist. of Chicago, 910 South Michigan Ave., Room 700, Chicago, Ill.		June 16, 1919
KEMMLER, EDWARD ALBERT. Engr. of Highways, Dept. of Public Service, Delaware Bldg., Akron, Ohio		May 12, 1919
KING, MAX WERNER. Dist. Mgr., Empire Eng. Co., Inc., 28 Beard Ave., Buffalo, N. Y.		May 12, 1919
KIRKHAM, JOHN EDWARD. Prof. of Structural Eng., Iowa State Coll.; Acting Head, Civ. Eng. Dept., Iowa Highway Comm., Ames, Iowa	Assoc. M. M.	Feb. 7, 1906 June 16, 1919
LANSDALE, JOHN. Maj., Engrs., U. S. A.; Chf., Railroad and Dock Constr. Section, D. C. and F., A. P. O. 717, Am. Exp. Forces, Tours, France	Assoc. M. M.	Sept. 11, 1917 April 14, 1919
LARUE, EUGENE CLYDE. Hydr. Engr., U. S. Geological Survey, Federal Bldg., Pasadena, Cal.	Assoc. M. M.	Jan. 4, 1910 June 16, 1919
LEAF, JAMES PINNEY. 290 West Park, Rochester, Pa.		April 14, 1919
LEE, CHARLES HAMILTON. Capt., Engrs., U. S. A., 2629 Piedmont Ave., Berkeley, Cal.	Jun. Assoc. M. M.	Jan. 2, 1906 Jan. 31, 1911 June 16, 1919
LEWIS, LUTHER HAMMOND. Archt. (Crow, Lewis & Wick), 200 Fifth Ave., New York City	Assoc. M. M.	April 6, 1904 May 12, 1919
MCGREGOR, ROBERT ROY. 1818 Bath St., Santa Barbara, Cal.	Assoc. M. M.	Mar. 6, 1907 April 14, 1919
MADDEN, JOHN HENRY. 515 West 111th St., New York City	Jun. Assoc. M. M.	Oct. 7, 1902 May 4, 1904 June 16, 1919
MARSHALL, RICHARD COKE, JR. Brig.-Gen., U. S. A., The Farnsboro, Washington, D. C.		May 12, 1919
MERRIAM, JUDSON HUNTOON. Res. Engr., C., B. & Q. R. R., Bridgeport (Res., Lincoln), Nebr.		June 16, 1919
NEEL, WARREN RABUN. State Highway Engr.; Secy. and Treas., State Highway Dept., 883 West Peachtree St., Atlanta, Ga.		May 12, 1919
NEELY, JOHN BURCHFIELD. Chf. Engr., Kansas City Bridge Co., 510 Orear Leslie Bldg., Kansas City, Mo.		May 12, 1919

MEMBERS (*Continued*)

		Date of Membership.
OLDS, ALBERT ROY. Engr., M. of W., Havana Elec. Ry., Light & Power Co., Box 570, Havana, Cuba	Assoc. M.	May 15, 1917
	M.	May 12, 1919
OREN, FRED BAILEY. Engr. and Contr., St. Elmo, Ill		April 14, 1919
PAUL, CHARLES EDWARD. Cons. Engr.; Prof. of Mechanics, Armour Inst. of Technology, Chicago, Ill		May 12, 1919
PELLISSIER, GEORGE EDWARD. Asst. Gen. Mgr. and Chf. Engr., Holyoke St. Ry., Holyoke, Mass.	Jun.	Feb. 28, 1905
	Assoc. M.	July 1, 1909
	M.	June 16, 1919
PERKINS, FRANK EDSON. Engr., Butterworth-Judson Corporation, Newark Transfer, Newark, N. J. (Res., 297 Farmington Ave., Hartford, Conn.)		May 12, 1919
RAPP, FRANK ARTHUR. Bridge Engr., City of Seattle, 600 County and City Bldg., Seattle, Wash.		June 16, 1919
ROBERTS, WARREN RUSSELL. Pres. and Chairman, Board of Directors, Roberts & Schaefer Co., 2064 McCormick Bldg., Chicago, Ill.		May 12, 1919
ROBINSON, ERNEST FRANKLIN. 118 Twenty-eighth St., Newport News, Va.	Jun.	Mar. 3, 1908
	Assoc. M.	Oct. 4, 1910
	M.	April 14, 1919
RUTH, EDGAR KINGSBURY. Asst. Prof. of Civ. Eng., Univ. of Cincinnati, Cincinnati, Ohio	Jun.	May 2, 1911
	Assoc. M.	July 2, 1913
	M.	June 16, 1919
SAMUELSON, BERNHARD MARTIN. 3 The Crescent, Scarborough, England		Mar. 11, 1919
SLOCUM, CURLYS LYON. Capt., Ord., U. S. A.; Asst. to Commanding Officer, Springfield Arsenal (Res., 30 Armory St.), Springfield, Mass.	Jun.	Jan. 3, 1905
	Assoc. M.	July 9, 1906
	M.	June 16, 1919
STERLING, PAUL. Maintenance Engr., Lines West and C. N. E., N. Y., N. H. & H. R. R., New Haven, Conn.		May 12, 1919
STOCKER, LESLIE WRIGHTSON. Asst. Engr., City Engr.'s Office, 3450 Geary St., San Francisco, Cal.	Assoc. M.	June 24, 1914
	M.	June 16, 1919
SYKES, GEORGE. (George Sykes Co.), 70 East 45th St., New York City	Jun.	May 1, 1906
	Assoc. M.	Dec. 4, 1907
	M.	May 12, 1919
TAY, SAMUEL WRIGHT. San. Engr., 2413 Lower Manoa Rd., Honolulu, Hawaii	Assoc. M.	June 24, 1914
	M.	June 16, 1919
TOWNSEND, JOSEPH BOYER. Southwestern Mgr., Div. of Constr. and Eng., Stone & Webster, 1008 Texas Ave., Houston, Tex.		May 12, 1919
WESTON, BENJAMIN THOMAS. Res. Engr., H. S. Ferguson, Temiskaming, Que., Canada	Assoc. M.	Sept. 3, 1912
	M.	June 16, 1919

MEMBERS (*Continued*)

	Date of Membership.
WETZLER, WILLIAM HENRY. Cons. Engr.; Prin. Surveyor of Concrete Ships, Am. Bureau of Shipping, 66 Beaver St. (Res., 120 Haven Ave.), New York City	April 14, 1919
WILSON, WILLIAM. Archt. and Engr., 53 Akashi-cho-Tsukiji, Tokyo, Japan	Assoc. M. Feb. 6, 1912 M. Jan. 14, 1919
WRIGHT, CLARK CHITTENDEN. Col., Q. M. C., U. S. A., Constr. Div., Apartment 301, The Rochambeau, Washington, D. C.	May 12, 1919
YATES, GEORGE STEVENSON. 68 rue du Lombard, Brussels, Belgium	May 12, 1919

ASSOCIATE MEMBERS

ALLING, ARTHUR RICH. 326 Gazette Bldg., Little Rock, Ark.	May 12, 1919
ANDERSON, ANDREW ELLIOTT. Box 189, Brownsville, Tex.	Jan. 13, 1919
ARNESON, EDWIN PERCIVAL. Irrig. and Highway Engr. (Walton & Arneson), 418 Gunter Bldg., San Antonio, Tex.	May 12, 1919
BADT, ROY ARIN. Cons. Engr. (Badt & Fisher), 74 New Montgomery St., San Francisco, Cal.	May 12, 1919
BALL, WENDELL PHILIP. Asst. Div. Engr., B. & O. R. R., New Castle, Pa.	Jan. 13, 1919
BARRETT, PETER THORNTON. Capt., Q. M. C., U. S. A., Constr. Div., 1330 Fairmount St., N. W., Washington, D. C.	June 16, 1919
BATES, GEORGE WHITNEY. City Engr., City Hall, Lincoln, Nebr.	June 16, 1919
BEER, FREDERICK MAX. Civ. Engr., Tank Shipbuilding Corporation, 240 Cooper St., Brooklyn, N. Y.	June 16, 1919
BENGEL, GEORGE ADAM. 808 South 4th St., Springfield, Ill.	June 16, 1919
BETTS, CLIFFORD AULL. Engr. of Constr., Standard Ground Rock Phosphate & Fertilizer Co., Centerville, Tenn.	Jun. Sept. 12, 1916 Assoc. M. May 12, 1919
BEUTTENMULLER, RUDOLF WILLIAM. Supt. of Dredging, Philadelphia Quartermaster Terminal, 5309 North 12th St., Philadelphia, Pa.	April 14, 1919
BIRD, HAROLD CRUSIUS. Prof. of Civ. Eng., Pennsylvania Military Coll., 2114 Madison St., Chester, Pa.	Jun. Nov. 27, 1917 Assoc. M. May 12, 1919
BISSELL, CHARLES ARTHUR. Engr., U. S. Reclamation Service, 539 Randolph St., N. W., Washington, D. C.	June 16, 1919
BLACKWELL, LINUS CRAMBLET. 1st Lieut., Engrs., U. S. A., 602d Engrs., Am. Exp. Forces; Address, Gen. Delivery, Bellevue, Pa.	Mar. 12, 1918

ASSOCIATE MEMBERS (*Continued*)

	Date of Membership.
BLYTH, ALEXANDER WATT. Estimator and Engr., Stillman-Delehanty-Ferris Co., 26 Exchange Pl., Jersey City, N. J.	June 16, 1919
BONNEY, GUY. 1730 North Calvert St., Baltimore, Md.	Mar. 11, 1919
BOWEN, EDWARD WITHERS. With The Hydr. Steelcraft Co., Cleveland, Ohio.	Jun. Nov. 12, 1913 Assoc. M. May 12, 1919
BRUCE, ERNEST ARDEN. 1222 Lee St., Charleston, W. Va.	April 14, 1919
BURR, FRANK MARVIN. Chf. Engr., Anglo-American Mill Co., 322 Clay St., Owensboro, Ky.	June 16, 1919
CHAMBERS, CHARLES. 530 Fifteenth Ave., West, Calgary, Alberta, Canada.	June 16, 1919
CHAPMAN, RONALD FARQUHAR. Ferncot, Staines, Middlesex, England.	Mar. 11, 1919
CLARK, FRANK JOSHUA. Junior Engr., U. S. Engr. Dept., First Dist., 500 West 143d St., New York City.	June 16, 1919
CLARK, HALE AUSTIN. Senior Structural Engr., Bureau of Valuation, Interstate Commerce Comm., 649 North Fulton Ave., Baltimore, Md.	April 14, 1919
CLAY, JAMES SINGLETON. Highway Bridge Engr., U. S. Bureau of Public Roads, 1743 F St., N. W., Washington, D. C.	May 12, 1919
CONNER, PERLEY EUGENE. Junior Engr., San. Dist. of Chicago, 712 Ash St., Winnetka, Ill.	April 14, 1919
CRAIG, WALTER DUNLAP. 3200 Clifton Ave., Baltimore, Md.	April 14, 1919
CUFF, JAMES EDWARD. Care, New York State Highway Comm., Syracuse, N. Y.	May 12, 1919
CURTIS, BENJAMIN JOHN. Res. Engr., San. Dist. of Chicago, 473 Elm St., Blue Island, Ill.	Jun. Sept. 2, 1914 Assoc. M. June 16, 1919
CURTISS, GREY WILLIS. Track Superv., N. Y., N. H. & H. R. R., 15 Academy St., South Braintree, Mass.	June 16, 1919
DALEN, JOHN ALBERT. Structural Engr., E. F. Terry Mfg. Co., Springfield Gardens, N. Y.	June 16, 1919
DANIELLS, PAUL ASHMORE. 284 Main St., Greenville, Pa.	May 12, 1919
DAVIS, RAYMOND EARL. 1st Lieut., Engrs., U. S. A., 641 O'Farrell St., San Francisco, Cal.	May 12, 1919
DEAN, NORMAN DOUGLAS. Lt.-Col., Engrs., U. S. A., Harbor St. and Sheridan Rd., Glencoe, Ill.	April 14, 1919
DE LEUW, CHARLES EDMUND. (Gates & De Leuw), 1742 Monadnock Blk., Chicago, Ill.	Jun. Aug. 31, 1915 Assoc. M. June 16, 1919
DENNETT, ROBERT CLARK. Engr., National Board of Fire Underwriters, 76 William St., New York City.	June 16, 1919
DIRATS, JANIK KEVORK. Engr. Mgr., Franco-American Agency, 54 rue Taitbout, Paris, France.	Jun. May 28, 1912 Assoc. M. May 12, 1919

ASSOCIATE MEMBERS (*Continued*)

	Date of Membership.
ELCOCK, CHARLES. 123 Bethlehem Pike, Chestnut Hill, Philadelphia, Pa.	June 16, 1919
EMERSON, CHARLES JOHN. 328 Custom House, San Francisco, Cal.	May 12, 1919
EPSTEIN, ABRAHAM. Structural Engr., 2001 West 39th St. (Res., 6163 South Michigan Ave.), Chicago, Ill.	May 12, 1919
FERVER, ARTHUR LEE. Plant Engr., Southwestern Shipbuilding Co., East San Pedro, Cal.	May 12, 1919
FINESTONE, NATHANIEL. Asst. Engr., Aguila Refinery, Cia. Mex. de Petroleo "El Aguila", S. A., Minatitlan, Mexico.	June 16, 1919
FISCHER, ANDREW, JR. 120 Montgomery St., Bloomfield, N. J.	June 16, 1919
FISCHER, WALTER ARTHUR. Hydr. Engr.; Advisory Engr. on Water Supply and Fire Protection, Constr. Div., U. S. A., Room 1-316, Bldg. C, 7th and B Sts., Washington, D. C.	June 16, 1919
FISHER, ALFRED PHILIP. Cons. Engr. (Badt & Fisher), 1016 Nevada Bank Bldg., San Francisco, Cal.	April 14, 1919
FLEMING, PHILIP BRACKEN. Col., Engrs., U. S. A.; Director of Drawing Dept., U. S. Engr. School, Camp A. A. Humphreys, Va.	May 12, 1919
FOLK, CHARLES JAMES. Asst. Engr., Valuation Dept., L. V. R. R., 62 Lewis St., Phillipsburg, N. J.	June 16, 1919
FOLLIN, JAMES WIGHTMAN. Capt., San. C., U. S. A., Office of Surgeon General, 3535 Thirteenth St., N. W., Washington, D. C.	Jun. Oct. 7, 1914 Assoc. M. May 12, 1919
FOX, ROBERT LEE. City Engr., 129 East Broad St., Bethlehem, Pa.	June 16, 1919
FRETZ, EDMOND ANTHONY. Chf. Engr., Horton & Horton, Box 916, Houston, Tex.	Jun. Feb. 4, 1913 Assoc. M. May 12, 1919
GALLAGHER, HERBERT MORGAN. Asst. Engr., So. Ry., Box 830, Meridian, Miss.	June 16, 1919
GARDNER, LEROY ERNEST. Capt., Q. M. C., U. S. A., Fort Ringgold, Tex.	April 14, 1919
GATES, GEORGE WILLIAM. Acting Res. Engr., Eastern Dist., Constr. Dept., N. Y. C. R. R., 382 Wadsworth Ave., New York City.	June 16, 1919
GAULT, JOHN JAMES. Pilot Engr., C. & A. R. R., 2920 Sheffield Ave., Chicago, Ill.	Jun. Mar. 2, 1915 Assoc. M. May 12, 1919
GEARHART, ORVAL LEE. 37 Dixon National Bank, Dixon, Ill.	June 16, 1919
GLAESER, FREDERICK. Engr., U. S. Shipping Board, Emergency Fleet Corporation, 38 South Hermitage Ave., Trenton, N. J.	May 12, 1919

ASSOCIATE MEMBERS (*Continued*)

	Date of Membership.
GLAETTLI, JOHN, JR. With U. S. Shipping Board, Emergency Fleet Corporation, Box 1413, San Diego, Cal..	June 16, 1919
GRAHAM, ROLAND RUSSELL. With Am. Bridge Co., 30 Church St., New York City (Res., 28 Carroll St., Yonkers, N. Y.) ..... { Jun. / Assoc. M.	May 15, 1917 / June 16, 1919
GREEN, GROVER CLEVELAND. Cottonwood, Cal.....	June 16, 1919
GRIFFIN, E. RAY. City Engr.; County Engr.; (Black & Griffin), Mandan, N. Dak.....	June 16, 1919
GUSTIN, LESTER CARLISLE. Pres. and Engr., Boston Structural Steel Co., 241 Albany St., Cambridge, Mass..	May 12, 1919
HAM, ROSCOE CONKLING. Transitman, Park Board Survey Party, 3728 Valentine Rd., Kansas City, Mo.....	June 16, 1919
HANGER, KENNETH HARROW. Care, C., R. I. & P. R. R., El Dorado, Ark.....	June 16, 1919
HANSON, FRED ERNEST. 185 Leete St., West Haven, Conn...	May 12, 1919
HARRIS, FRANK WILLIAM. 905 East 6th St., Olympia, Wash.....	May 12, 1919
HAVENS, HARRY LUCAS. Structural Engr., 400 Graphic Arts Bldg., Kansas City, Mo.....	April 14, 1919
HEARN, RICHARD LANKASTER. Asst. to Hydr. Engr., Hydro-Elec. Power Comm. of Ontario, 229 Havelock St., Toronto, Ont., Canada.....	May 12, 1919
HEIN, PETER LEO. (Lieberman, Klein & Hein), Room 538, State Lake Bldg., Chicago, Ill.....	June 16, 1919
HESSION, JOHN HENRY. Dist. Engr., Corrugated Bar Co., 592 Huron Ave., Cambridge, Mass.....	June 16, 1919
HICKS, PRESTON THOMAS. Cons. Engr.; City Engr. and Engr. to San. Dist. of Decatur, Court House (Res., 119 South Edward St.), Decatur, Ill.....	June 16, 1919
HITCHCOCK, ARTHUR BEERS. Mgr., Paving Dept., The Barrett Co., 325 South Jackson Ave., Kansas City, Mo..	June 16, 1919
HOFF, FRANK WARNE. With Universal Portland Cement Co., 929 Belmont Ave., Youngstown, Ohio.....	June 16, 1919
HOLLISTER, SOLOMON CADY. Designer, Concrete Ship Section, Emergency Fleet Corporation, 4420 Chestnut St., Philadelphia, Pa.....	May 12, 1919
HOPKINS, JOHN THOMAS. Borough Engr., Highland Park (Res., 59 Lincoln Ave., New Brunswick), N. J.....	June 16, 1919
HUGHES, CHARLES WARREN. Asst. City Engr., 2147 Fifth St., Port Arthur, Tex.....	May 12, 1919
HUNTLEY, LEE HARVEY. Res. Engr., Demerara Bauxite Co., Box 214, Georgetown, British Guiana.....	May 12, 1919
HUSSEY, LAWRENCE. 1334 Seventh St., San Diego, Cal....	Jan. 13, 1919
JERVIS, CHARLES MILLER. Civ. Engr., The Cupey Sugar Co., Cupey, Oriente, Cuba.....	Mar 11, 1919

ASSOCIATE MEMBERS (*Continued*)

	Date of Membership
JOHNSON, HAROLD SUCESE. Supt., Dawson Constr. Co., 1026 West Washington St., San Diego, Cal.	May 12, 1919
JOHNSTON, JOHN WALLACE. Promotion Engr., Portland Cement Assoc., 408 Union Trust Bldg., Parkersburg, W. Va.	June 16, 1919
KELLY, PRESCOTT VAIL. 1200 Jones Bldg., Pittsburgh, Pa.	May 12, 1919
KIMBRELL, GEARY. County Highway Engr., and City Engr., Pendleton, Ore.	June 16, 1919
KNISKERN, PHILLIP WHEELER. Capt., Engrs., U. S. A., 4458 Drexel Boulevard, Chicago, Ill.	Jun. Sept. 12, 1916 Assoc. M. June 16, 1919
LAMB, SYDNEY BISHOP. Draftsman, Valuation Dept., Colo. & South. Ry. (Res., 2652 Lafayette St.), Denver, Colo.	Jun. Jan. 7, 1913 Assoc. M. June 16, 1919
LEECH, EDWARD. Care, Art Metal Constr. Co., Jamestown, N. Y.	June 16, 1919
LEVINE, HAROLD JULIUS. Cons. and Industrial Engr. (Kaufman & Levine), 21 East 40th St., New York City	May 12, 1919
LIDDELL, NATHANIEL MORRIS. Engr. in Chg. of Road Constr., Care, County Engr., Court House, Topeka, Kans. (Res., 508 West Harrison St., Danville. Ill.)	June 16, 1919
LOCKWOOD, REX BARNUM. Chf. Engr., Atlantic, Gulf & Pacific Co. of Manila, Box 626, Manila, Philippine Islands.	April 14, 1919
LOMAX, NELSON JOHNSON. Res. Engr., Waddell & Son, 800 Graphic Arts Bldg., Kansas City, Mo.	June 16, 1919
MCHENRY, REYNOLDS. Engr., Leland S. Rosener, 2975 Pacific Ave., San Francisco, Cal.	Mar. 11, 1919
MANDELL, SOLON BARON. With the Submarine Boat Corporation, 1 West 85th St., New York City	May 12, 1919
MARDEN, LESLIE ONA. Chf. Draftsman, North Dakota State Highway Comm., 615 Second St., Bismarck, N. Dak.	Mar. 11, 1919
MARKHART, CLARK ORROMELL. 1319 Fulton Bldg., Pittsburgh, Pa.	Jan. 13, 1919
MARSHALL, LESLIE STANCLIFFE. Chf. of Party, Emergency Fleet Corporation, 525 Collings Ave., West Collingswood, N. J.	May 12, 1919
MILLER, DEMONT GEORGE. Sales Mgr., Layne & Bowler Corporation, 900 Santa Fe Ave., Los Angeles, Cal.	June 16, 1919
MULLINS, JOE BURROW. Civ. and Area Engr., Dupont Eng. Co., Flint, Mich.	May 12, 1919

ASSOCIATE MEMBERS (*Continued*)

	Date of Membership.
MULLINS, THOMAS CLINTON. Capt., Engrs., U. S. A., Co. C, 34th Engrs., Am. Exp. Forces, France; Address, Boonville, Ind	Jan. 13, 1919
MYERS, PATRICK HENRY. Chf. Engr. and Railroad Supt., Cuyamel Fruit Co., Cuyamel, Spanish Honduras, *via* New Orleans, La	May 12, 1919
NASH, JAMES PHILIP. Office Engr., Texas State Highway Dept. (Res., 1501 Colorado St.), Austin, Tex	Mar. 11, 1919
NIGHSWONGER, HARRISON WORTH. 13th Floor, Colcord Bldg., Oklahoma, Okla	May 12, 1919
OAKES, BETHUEL SUTHERLAND. Superv. Plant Engr., U. S. Shipping Board, Emergency Fleet Corporation, Box 561, Wilmington, N. C	May 12, 1919
O'CONNOR, FRANCIS BARNARD. Asst. Chf. Engr., Alphons Custodis Chimney Constr. Co., 95 Nassau St. (Res. 1 Lexington Ave.), New York City	June 16, 1919
ORR, SCOTT WESLEY. Designing Engr., Fay, Spofford & Thorndike, 58 County Rd., Chelsea, Mass	June 16, 1919
OTTO, OLAF. Civ. Engr. and Contr., 301 Savannah Bank & Trust Bldg., Savannah, Ga	June 16, 1919
PATTERSON, CHARLES ARTHUR. Borough Engr., City Hall Bldg., Torrington, Conn	June 16, 1919
RIDLEY, CLARENCE EUGENE. City Engr., City Hall, Port Arthur, Tex	May 12, 1919
ROSE, ALEXANDER. Structural Engr., 632 Builders Exchange, Minneapolis, Minn	Nov. 26, 1918
RYAN, JAMES TILLMAN. Valuation Engr., Pacific Gas & Elec. Co., 445 Sutter St., San Fransisco, Cal	May 12, 1919
SAVILLE, THORNDIKE. Associate Prof. of San. Eng., Univ. of North Carolina, Chapel Hill, N. C	May 12, 1919
SEABROOK, HUGH RAYNER. Royal Societies Club, 63 St. James St., London, S. W., England	June 16, 1919
SHANK, JACOB RALPH. Asst. Prof., Civ. Eng., The Ohio State Univ., 97 West Tompkins St., Columbus, Ohio	June 16, 1919
SHEA, WILLIAM JAMES. Maj., Engrs., U. S. A., 1515 Sixteenth St., N. W., Washington, D. C	May 12, 1919
SINCLAIR, LEONARD HANSCOME, Asst. Project Mgr., U. S. Navy Dept., Room 2916, Navy Bldg., Washington, D. C	Jun. Oct. 1, 1913 Assoc. M. May 12, 1919
SORZANO, CARLOS TEJADA. Casilla 276, La Paz, Bolivia	May 12, 1919
STANFIELD, ADRIAN CLYDE. Pana, Ill	June 16, 1919
STAPE, GEORGE PHILIP ALEXANDER. Planning Engr., The Dayton Wright Airplane Co., Research Div., 127 North Ludlow St., Dayton, Ohio	April 14, 1919

ASSOCIATE MEMBERS (*Continued*)

	Date of Membership.
STEARNS, FRED LEROY. 173 Hicks St., Brooklyn, N. Y. — Jun.	April 2, 1912
— Assoc. M.	May 12, 1919
STEIN, BENJAMIN. Engr., Hennebique Const. Co., 5 Elizabeth Court, Beach 40th St., Edgemere, N. Y.	June 16, 1919
STRACHAN, JOSEPH JOSLIN. Lieut., C. E. C., U. S. N., U. S. Navy Yard, Boston, Mass. — Jun.	April 7, 1915
— Assoc. M.	May 12, 1919
TALBOT, LYMAN ROBERT. 1811 Ross St., Sioux City Iowa	May 12, 1919
TAYLOR, MARCUS PREVOST. Capt., Engrs., U. S. A., Care, Dept. Engr., Fort Sam Houston, San Antonio, Tex.	May 12, 1919
TILTON, GEORGE ALBERT, JR. Res. Engr., California Highway Comm., 1703 Chorro St., San Luis Obispo, Cal. — Jun.	Sept. 12, 1916
— Assoc. M.	June 16, 1919
TRASK, WARREN DUDLEY. Asst. Div. Engr., Fay, Spofford & Thorndike, 22 Bartlett St., Somerville, Mass.	Mar. 11, 1919
TYLER, JAMES. Asst. City Engr., Town Hall, Auckland, New Zealand	Mar. 11, 1919
TYNDALL, ARTHUR. Care, Public Works Dept., Wellington, New Zealand	Mar. 11, 1919
WALLIS, RICHARD PARKER. Engr., Frank E. Wallis & Son, 56 West 45th St., New York City	June 16, 1919
WALTER, LLOYD DEWITT. Bee Bldg., Omaha, Nebr	June 16, 1919
WARE, SAMUEL HOUSTON. Capt., Engrs., U. S. A., Camp A. A. Humphreys, Va	May 12, 1919
WENSTRAND, RALPH THEODORE. Contr., Western Bridge & Constr. Co., 648 Bee Bldg., Omaha, Nebr	June 16, 1919
WEST, FRANK HUBBLE. Care, Hawaiian Contr. Co., Ltd., Hilo, Hawaii	May 12, 1919
WILLIAMS, TIMOTHY SILAS. Asst. to Concrete Engr., Westinghouse, Church, Kerr & Co., 37 Wall St., Room 912, New York City	June 16, 1919
WINSHIP, LEF. Asst. to Chf. Engr., Mo. Pac. R. R., 4138 Cleveland Ave., St. Louis, Mo	June 16, 1919
WISLER, CHESTER OWEN. Camp Davis, Topinabee, Mich.	April 14, 1919
WITTE, HERMAN CALVERT. Structural Engr., Concrete Ship Dept., Emergency Fleet Corporation, 3733 Locust St., Philadelphia, Pa	May 12, 1919
WOLFE, WILLIAM SIDNEY. Structural Engr., Smith, Hinchman & Grylls, Washington Arcade, Detroit, Mich.	May 12, 1919
WONG, JICK GAM. Res. Engr., Sections 7 and 10, Hankow-Ichang Ry., Han-I Ry. Office, Tsaoshih, Hupeh Prov., China — Jun.	Oct. 7, 1914
— Assoc. M.	Mar. 11, 1919
WOOD, CLYDE WARREN. Asst. Engr., South San Joaquin Irrig. Dist., Manteca, Cal.	June 16, 1919
ZEHR, VRATISLAV ADOLPH. Cons. Engr., E. T. Perkins Eng. Co., Box 119, Pekin, Ill.	June 16, 1919

ASSOCIATES

	Date of Membership.
Carpenter, Ford Ashman. Meteorologist, U. S. Weather Bureau, Los Angeles, Cal.	June 16, 1919
Irwin, William Clark. Sales Engr., Railroad and Contractors' Supplies, 603 Frisco Bldg., St. Louis, Mo.	June 16, 1919
Walker, Frank Rabold. Bldg. Contr. (Frank R. Walker Co.), 168 North Michigan Ave., Chicago, Ill.	June 16, 1919

JUNIORS

Bayer, Harry Lewis. With H. S. Ferguson, Temiskaming, Que., Canada	June 16, 1919
Brockway, Warner Cotton. 2d Lieut., San. C., U. S. A.; Camp San. Engr., Camp Bragg, N. C.	April 14, 1919
Burke, Michael Joseph. 1301 Charleston St., Mattoon, Ill.	June 16, 1919
Camlin, William John. Care, Minnesota Highway Dept., St. Paul, Minn.	May 12, 1919
Dias, Moacyr Rodrigues. 20 Rua Sabara, São, Paulo, Brazil	Mar. 11, 1919
Foster, James Apker. Junior Highway Engr., State of Illinois, 302 Apollo Theatre Bldg., Peoria, Ill.	May 12, 1919
Griffith, James Rinaldo. 619½ West Howard St., Muncie, Ind.	May 12, 1919
Grupe, Edgar Young, Jr. Aeronautical Engr., Eng. Dept., U. S. A., Fort Omaha, Nebr.	April 14, 1919
Guest, John Henry. City Hall, Pine Bluff, Ark.	April 14, 1919
Harn, John Edwin. 2314 Oak St., Baltimore, Md.	May 12, 1919
Heywood, Gene Bryant. Care, Southern California Edison Co., Kernville, Cal.	June 16, 1919
Kane, Wallace Byrne. 212 Frisco Bldg., Joplin, Mo.	May 12, 1919
Kuchar, Joseph Jaromir. Asst. Engr. to Res. Engr., J. G. White Eng. Corporation, Muscle Shoals, Ala.	June 16, 1919
Luhrs, Albert Weigand. Transitman, M. of W. Dept., Erie R. R., 150 North St., Jersey City, N. J.	May 12, 1919
McSweeney, Thomas Francis. 1 Salem End Rd., Framingham, Mass.	May 12, 1919
Miao, En-Chao. Care, K. S. Yuen, Box 835, U. S. Postal Agency, Shanghai, China	May 12, 1919
Robertson, Louis Wellington. 2d Lieut., Engrs., U. S. A., Box 85, El Paso, Tex.	May 12, 1919
Sopp, Claude Wellington. Junior Engr., U. S. Geological Survey, Box 519, Pasadena, Cal.	June 16, 1919
Thompson, Missac. Reinforced Concrete Engr., 640 Broadway, New York City	June 16, 1919
Triana, Jorge. Ingeniero Jefe, Ferrocarril del Tolima, Box No. 5, Bogota, Colombia	Mar. 11, 1919

JUNIORS (*Continued*)

	Date of Membership.
VICKERS, PAUL AMOS. 3028 Harrison St., Kansas City, Mo.	June 16, 1919
WEISKOPF, EDWARD FRANCIS. 11 East 42d St., New York City	April 14, 1919
WELLS, CLIFTON KENNADY, JR. Contr. and Builder (Constable-Wells Co.). 2919 Guilford Ave., Baltimore, Md.	May 12, 1919

REINSTATEMENTS

MEMBERS

	Date of Reinstatement.
SPOONER, HERMAN WINSLOW	June 16, 1919

RESIGNATIONS

ASSOCIATE MEMBERS

	Date of Resignation.
HARMON, WATSON GILBERT	June 16, 1919

JUNIORS

HALLBERG, ARTHUR SIDNEY	June 16, 1919
YOUNGLING, LOUIS SHEMALD	June 16, 1919

DEATHS

ALLEN, HERMON CHARLES. Elected Member, May 2d, 1911; died May 4th, 1919.

CHASE, DEAN. Elected Junior, June 3d, 1915; died May 26th, 1919.

DOBSON, ADNA. Elected Member, May 6th, 1908; died May 4th, 1919.

FORD, WILLIAM GRIFFING. Elected Member, October 5th, 1904; died June 23d, 1919.

HARDY, HARRY. Elected Associate Member, June 1st, 1892; Member, June 1st, 1909; died April 4th, 1919.

HAVILAND, ARTHUR. Elected Junior, January 4th, 1882; Member, January 4th, 1888; died June 18th, 1919.

HENDRIE, JOHN GIBSON. Elected Junior, September 5th, 1911; Associate Member, April 2d, 1913; Member, May 12th, 1919; died June 18th, 1919.

HENLEY, ROBERT DWIGGINS MONTEITH. Elected Junior, September 3d, 1901; Associate Member, January 31st, 1911; died May 3d, 1918.

NICHOLS, ALLEN EUGENE. Elected Associate Member, October 10th, 1916; died May 8th, 1919.

OWENS, HENRY KINDER. Elected Member, March 6th, 1889; died May 15th, 1919.

PETHERAM, GEORGE THOMAS. Elected Associate Member, February 28th, 1911; died October, 1918.

RITTER, HOMER PETER. Elected Member, November 3d, 1915; died April 21st, 1919.

Sauerman, Henry Burger. Elected Associate Member, May 1st, 1907; Member, May 31st, 1916; died May 20th, 1919.

Schussler, Hermann Frederick August. Elected Member, February 4th, 1914; died April 27th, 1919.

Shiraisha, Naoji. Elected Member, October 4th, 1899; died February 17th, 1919.

Speidel, Hugo S. Elected Junior, February 5th, 1890; died June 17th, 1919.

Stephens, George Hippesley Stanley. Elected Associate Member, December 5th, 1911; died December 13th, 1918.

Stimson, Burt. Elected Associate Member, September 12th, 1916; died May 26th, 1919.

Swensson, Emil. Elected Member, June 7th, 1893; died May 13th, 1919.

Torralbas, Rafael Joaquin. Elected Junior, November 1st, 1910; Associate Member, June 24th, 1914; died September 25th, 1918.

Uhlig, Carl. Elected Member, October 7th, 1903; died May 5th, 1919.

White, John Wesley. Elected Junior, April 14th, 1919; died June 2d, 1919.

Total Membership of the Society, August 8th, 1919, 9 190.

MONTHLY LIST OF RECENT ENGINEERING ARTICLES OF INTEREST

(May 1st to July 17th, 1919)

NOTE.—*This list is published for the purpose of placing before the members of this Society, the titles of current engineering articles, which can be referred to in any available engineering library, or can be procured by addressing the publication directly, the address and price being given wherever possible.*

LIST OF PUBLICATIONS

In the subjoined list of articles, references are given by the number prefixed to each journal in this list:

(2) *Journal,* Engrs. Club of Phila., Philadelphia, Pa.
(3) *Journal,* Franklin Inst., Philadelphia, Pa., 50c.
(4) *Journal,* Western Soc. of Engrs., Chicago, Ill., 50c.
(5) *Journal,* Eng. Inst. of Canada, Montreal, Que.
(6) *Journal,* Am. Inst. of Archts., Washington, D. C., 50c.
(7) *Gesundheits Ingenieur,* Munich, Germany.
(8) *Stevens Indicator,* Hoboken, N. J., 50c.
(9) *Industrial Management,* New York City, 25c.
(11) *Engineering* (London), W. H. Wiley, 432 Fourth Ave., New York City, 25c.
(12) *The Engineer* (London), International News Co., New York City, 35c.
(13) *Engineering News-Record,* New York City, 15c.
(15) *Railway Age,* New York City, 15c.
(16) *Engineering and Mining Journal,* New York City, 15c.
(17) *Electric Railway Journal,* New York City, 10c.
(18) *Railway Review,* Chicago, Ill., 15c.
(19) *Scientific American Supplement,* New York City, 10c.
(20) *Iron Age,* New York City, 20c.
(21) *Railway Engineer,* London, England, 1s. 2d.
(22) *Iron and Coal Trades Review,* London, England, 6d.
(24) *American Gas Engineering Journal,* New York City, 10c.
(25) *Railway Mechanical Engineer,* New York City, 20c.
(26) *Electrical Review,* London, England, 4d.
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(28) *Journal,* New England Water-Works Assoc., Boston, Mass., $1.
(29) *Journal,* Royal Soc. of Arts, London, England, 6d.
(32) *Mémoires et Compte Rendu des Travaux,* Soc. Ing. Civ. de France, Paris, France.
(33) *Le Génie Civil,* Paris, France, 1 fr.
(36) *Cornell Civil Engineer,* Ithaca, N. Y.
(40) *Zentralblatt der Bauverwaltung,* Berlin, Germany, 60 pfg.
(41) *Elektrotcchnische Zeitschrift,* Berlin, Germany.
(42) *Proceedings,* Am. Inst. Elec. Engrs., New York City, $1.
(43) *Annales des Ponts et Chaussées,* Paris, France.
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(53) *Zeitschrift,* Oesterreichischer Ingenieur und Architekten-Verein, Vienna, Austria, 70h.
(54) *Transactions,* Am. Soc. C. E., New York City, $16.
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(57) *Colliery Guardian,* London, England, 5d.
(58) *Proceedings,* Engrs.' Soc. of W. Pa., 2511 Oliver Bldg., Pittsburgh, Pa., 50c.
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(60) *Municipal and County Engineering,* Indianapolis, Ind., 25c.
(61) *Proceedings,* Western Railway Club, 225 Dearborn St., Chicago, Ill., 25c.
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(71) *Journal,* Iron and Steel Inst., London, England.
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(83) *Gas Age,* New York City, 15c.
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LIST OF ARTICLES

Bridges.

The Coblenz Pontoon Bridge.* J. W. Skelly. (100) Mar.
Filling Trestles on the Southern Pacific. W. E. Burns. (87) May.
Recommended Procedure in the Painting and Maintenance of Highway Bridges. Charles D. Snead. (Paper read before Univ. of Kentucky Road School.) (60) May.
Studying the Defects in Masonry Structures.* (87) May.
Raising Allegheny River Bridge 13 Ft. by Jacking.* (13) May 1.
Reinforcement of Bridge by Means of an Eccentric Chord.* (13) May 8.
A Survey of Electric Railway Bridge Maintenance.* R. C. Cram. (17) May 17.
Design of New Superstructure of Louisville Bridge with 644-Ft. Riveted Span.* (13) May 22.
Pneumatic Caissons with Wooden Cylinders for Sinking Bridge Piers.* (86) May 28.
Maintaining Traffic During Erection of Louisville Bridge.* (13) May 29.
The Replacement of the Delaware River Bridge.* (Philadelphia, Pa.) Warren P. Laird. (2) June.
Concrete in Roads, Bridges and Culverts.* H. Eltinge Breed. (Paper read before Canadian Good Roads Congress.) (60) June.
Reinforced Concrete Bridges and Their Architectural Treatment.* F. G. Engholm. (67) June.
Tests to Free Under Side of Railroad Viaducts from Smoke. (13) June 12.
Yielding Barriers Close Roads at Drawbridges.* (13) June 12.
Lighting and Control for Bridge Over the Columbia.* F. H. Murphy. (27) June 14.
Construction of New Arch Section of Galveston Causeway.* (13) June 19.
Rebuilding the Genesee River Bridge, Lehigh Valley R. R., at Wadsworth, N. Y. (18) June 21.
Points Requiring Special Observation and Investigation in Bridge Inspection. Herbert C. Keith. (From paper read before Brooklyn Engrs. Club.) (86) June 25.
Railway Bridge Design: Loadings and Actual Engine Loads.* B. R. Leffler. (13) June 26.
How an Old Masonry Arch Bridge Was Rebuilt.* (87) July.
The Bloor Street Viaduct, Toronto, Ontario.* Thomas Taylor. (5) July.

* Illustrated.

Bridges—(Continued).

Problems Encountered in the Design of 12th Street Bridge.* (Chicago, Ill.) Hugh E. Young. (117) July 1.
Comparison of Five Railway Bridge Specifications.* (13) July 3.
Special Design Features and Erection Methods for 540-Ft. Suspension Bridge.* William G. Grove. (13) July 3.
American Engineers Make Records in Bridging the Rhine.* James M. Farrin and Sam H. Andrews. (13) July 17.
Bac-Transbordeur et Pont Tournant pour la Traversée du Canal Maritime de Suez à Kantara.* Jean Raimondi. (33) Mar. 15.
Les Ponts-Routes Militaires de l'Armée Anglaise.* R. Méchin. (33) Apr. 12.
Die Vollendung der Brücke über den St. Lorenzstorm bei Quebec. Wernekke. (40) Jan. 29.
Neubau der Strassenbrücke über die Klodnitz im Zuge der Wilhelmstrasse in Gleiwitz i Oberschlesien.* Borchard. (40) Feb. 8.
Neue Bauarten zerlegbarer Brücken.* Rudolf Bernhard. (40) Feb. 15.
Die Schwebefähre in Bordeaux.* A. Walther. (107) Apr. 12.
Zur Frage der Zulässigen Spannungen in Beton-Brückengewolben.* A. O. Lusser. (107) May 3.

Electrical.

The Development of Anti-Aircraft Searchlights.* James B. Cress. (100) Mar.
The Determination of the Efficiency of the Turbo-Alternator.* S. F. Barclay and S. P. Smith. (77) Apr.
Voltage Regulation.* J. Humphrey. (22) Apr. 18.
Distribution of Heat, Light and Motive Power by Gas and Electricity. Dugald Clerk. (29) Apr. 18.
The Electrical Features of Hog Island Shipyard.* H. W. Osgood. (Paper read before Assoc. of Iron and Steel Elec. Engrs.) (2) May.
The Susceptibility of Feebly Magnetic Materials.* Ernest Wilson. (77) May.
Utilizing the Time Characteristics of Alternating Current. Henry E. Warren. (42) May.
Transatlantic Radio Reception.* Charles A. Culver. (3) May.
On the Determination of the Electrical and Acoustic Characteristics of Telephone Receivers.* Louis V. King. (3) May.
Lighting of San Francisco's Triangle District.* A. F. Dickerson. (111) May 1.
Sparking Power of Magnetos.* Harry F. Geist. (120) May 1.
Outdoor Substations for Intercounty Development.* (27) May 3.
The Proper Loading of Distribution Transformers. Frank A. Robbins. (Paper read before Wisconsin Elec. Assoc.) (27) May 3.
Rewinding 12 000-Kw. Turbo-Generator Field.* (27) May 3.
Interborough Commissions 60 000-Kw. Turbo-Generator Unit.* W. S. Finlay, Jr. (17) May 10; (27) May 10.
Electric Service in World's Largest Hotel.* (27) Serial beginning May 10.
The Continuous-Rated Motor and Its Application. L. F. Adams. (27) May 10; (19) June 21.
Electric and Elevator Equipment of the Hotel Pennsylvania.* Chas. E. Knox. (64) May 13.
Leaks and Wastes in State Institutions. F. J. McCullough. (64) May 13.
Electrical Precipitation of Solids from Flue Gases.* J. M. Wauchope. (117) May 15.
Direct Current *vs.* Power Factor.* F. E. Austin. (19) May 17.
Adopting Automatic Control to Motor-Started Converters.* R. J. Wensley. (17) May 17.
Power Installation at the Old Hickory Powder Plant near Nashville, Tennessee.* (64) May 20.
The Electrical Equipment of the U. S. S. *New Mexico.** (From *General Electric Review.*) (26) May 23.
The Running of Mercury Rectifiers in Parallel.* Bela Schäfer. (Abstract of article in *Elektrotechnische Zeitschrift.*) (73) May 23.
Underground Construction and Electrolysis. (Extract from Report of Committee read before N. E. L. A.) (27) May 24.
Theory of the Aron Meter: A Note on the Effect of Impulsive Forces on Pendulums. H. G. Rowledge. (73) May 30.
The Electrical Equipment of H. M. Factory, Gretna.* A. S. Croso. (26) Serial beginning May 30.
Cost Comparison of Transformer Types.* B. C. Dennison. (27) May 31.
Features of Mammoth Waterwheel Generator.* (27) May 31.
The Dielectric Field in an Electric Power Cable.* R. W. Atkinson. (42) June.
Problems of 220-Kw. Power Transmission.* A. E. Silver. (42) June.
An Application of the Radiometer to the Measurement of Electric Current.* Thomas D. Cope. (3) June.
Tree Telephony and Telegraphy.* George O. Squier. (3) June.

* Illustrated.

Electrical—(Continued),

Transmission Line Relay Protection.* H. R. Woodrow and others. (42) June.
Grounding the Neutral of Generating and Transmission Systems.* H. R. Woodrow. (42) June.
The Effect of Transient Voltages on Dielectrics, II.* F. W. Peek, Jr. (42) June.
High-Tension Single-Conductor Cable for Polyphase Systems.* W. S. Clark and G. B. Shanklin. (42) June.
Air Fans for Driving Generators on Airplanes.* G. Francis Gray and others. (55) June.
Power Factor and Phase Rotation.* Leslie F. Curtis. (111) June 1.
Mercury Arc Tube Operation.* R. W. Kidd. (111) June 1.
Pulling Conductors into Conduits.* Terrell Croft. (64) June 3.
Know Your Battery Better. J. H. Tracy. (Paper read before Illinois Min. Inst.) (45) June 5.
Wireless Telephony and Direction Finding.* (12) June 6.
Hysteresis and Eddy-Current Losses in Iron at Radio Frequencies.* Christian Nusbaum. (Abstract of paper read before Am. Inst. of Radio Engrs.) (73) June 6.
A Method of Calibrating Meters.* H. Gewecke and W. Von Krukowski. (From *Elektrotechnische Zeitschrift.*) (73) June 6.
Electric Propulsion for the U. S. S. *New Mexico.** C. S. Raymond. (From *General Electric Review.*) (19) Serial beginning June 7.
Car Dumpers.* James A. Jackson. (From *General Electric Review.*) (16) June 7.
External-Anode Vacuum Tube.* H. P. Donle. (27) June 7.
Improvements in Industrial Plant Operation.* E. E. George. (27) June 7.
The Construction of 120- and 240-Volt Electromagnets and Solenoids.* Henry W. Townsend. (64) June 10.
Calculating Induction-Motor Magnetizing Current.* C. M. Laffoon. (27) June 14.
Rehabilitation of New York Cotton Mill.* (27) June 14.
Lighting and Control for Bridge Over the Columbia.* F. H. Murphy. (27) June 14.
Experiences with Electrolytic Arresters.* (27) June 14.
Influence of the Magnetic Field on the Initial Phase of the Electric Discharge. Auguste Righi. (From *Annales de Physique.*) (19) June 14.
Heating of Buildings by Electricity.* V. H. Greisser. (Report read before Idaho Public Utilities Comm.) (111) June 15.
Experience with Electric Heating in the Northwest.* J. D. Ross. (Report read before Idaho Public Utilities Comm.) (111) June 15.
A Simple Method of Determining Power-Factor Correction.* Ralph Kelly. (64) June 17.
A 3 000-H. P. Mill Motor by the G. E. C.* (73) June 20.
Station Load and Economy.* Ths. Norberg Schulz. (73) June 20.
Insuring Durability of the Pole-Top Fittings.* Charles R. Harte. (17) June 21.
How Spacing and Thickness of Brushes Affect Commutation.* Warren C. Kolb. (64) June 24.
Electricity Supply at Shanghai.* T. H. U. Aldridge. (26) June 27.
The Practicability of Transmission Lines at Highest Voltages in this Country.* G. U. Twiss. (73) June 27.
Aluminium Conductors for Overhead Power Transmission Lines.* Arthur Jacob. (73) June 27.
The New Power Station at Rotherham.* (73) Serial beginning June 27.
A Rectangular-Component Two-Dimensional Alternating-Current Potentiometer.* A. E. Kennelly and Edy Velander. (3) July.
High Frequency Currents on Wires. J. O. Mauborgne. (3) July.
Industrial Lighting.* C. E. Clewell. (Paper read before the Illuminating Eng. Soc.) (3) July.
The Absolute Measurement of the Intensity of Sound.* Arthur Gordon Webster. (42) July.
Notes on Suspension Insulator Design.* H. L. Garbutt. (111) July 1.
Single-Phase Load on a Two-Phase System.* J. B. Gibbs. (64) July 1.
Acquired Radio-Activity. William Crookes. (From *Philos. Trans.,* Royal Soc., and *Chemical News.*) (19) Serial beginning July 5.
Rapid Testing of Magnetic Materials.* Thomas Spooner. (27) July 5.
Overload Protection for Electric Motors.* O. C. Callow. (64) July 8.
Electrical Transmission of Power in and About Coal Mines. S. W. Farnham. (Abstract of paper read before Illinois Min. Inst.) (45) July 10.
Current Distribution in Armature Conductors.* Waldo V. Lyon. (27) July 12.
Northwest Pennsylvania's Newest Station.* J. B. Scott. (27) July 12.
Standardized Industrial Lighting Systems.* W. L. Cornelison. (27) July 12.
Factors in Obtaining Maximum Output from Hydro-Electric Plants. Fred A. Abner. (From the 1919 Report, Prime Movers Committee, National Elec. Light Assoc.) (64) July 15.
Reverse-Current Relays—Principles of Operation.* Victor W. Todd. (64) July 15.

* Illustrated.

Electrical—(Continued).

La Station Centrale Thermo-Electrique de Västeras (Suède).* (33) Apr. 12.
Nouvelles Installations dans les Grandes Stations Centrales des Etats-Unis; Groupes Turbo-Moteurs à Vapeur de 50 000 et 60 000 Kilowatt.* (33) May 24.
Connexions à la Terre des Systèmes de Distribution Electrique. (33) May 31.
Formeln für die Grosse elecktrischer Maschinen. L. Klein. (41) Jan. 2.
Die Begrenzung des Erdschlussstromes und die Unterdrückung des Erdschluss Lichtbogens durch die Erdschlusspule.* W. Petersen. (41) Serial beginning Jan. 2.
Beitrag zur Entwicklung des Fernsprech-Nebenstellenwesens. Franz Hendrichs. (41) Jan. 2.
Ueber die Grenzen der Kraftübertragung durch Wechselstrome. M. Dolivo-Dobrowolsky. (41) Jan. 2.
Unterirdische und oberirdische Wechselstrom-Höchstleistungskabel.* W. Kummer. (107) May 10.

Marine.

The U. S. Electrically-Propelled Battleship *New Mexico*. S. M. Robinson. (11) Apr. 25.
The Electrical Features of Hog Island Shipyard.* H. W. Osgood. (Paper read before Assoc. of Iron and Steel Elec. Engrs.) (2) May.
The Navigational Magnetic Compass Considered as an Instrument of Precision.* M. B. Field. (77) May.
Our Latest Dreadnought *Idaho*. (46) May 3.
The Propulsion of the Modern Submersible Torpedo Boat. Norman H. Wood. (Abstract of paper read before Inst. of Marine Engrs.) (26) May 9.
Water-Tube Boilers for Cargo Ships. (12) May 16.
Electrically-Driven Ships' Auxiliaries.* (12) May 16
Concrete Shipbuilding at Barrow-in-Furness.* W. Noble Twelvetrees. (11) May 16.
The Cast Steel Ship Development.* Myron F. Hill. (20) May 22.
The Electrical Equipment of the U. S. S. *New Mexico*.* (From *General Electric Review*.) (26) May 23.
Design and Construction of Flying-Boats.* David Nicholson. (Paper read before Inst. of Engrs. and Shipbuilders in Scotland.) (11) May 23.
Westinghouse-Rateau Marine Geared Turbine Installation.* (11) May 23.
Design and Construction of Navy Concrete Oil Barges.* R. M. Burkhalter. (13) May 29.
Turbine-Driven Pipeless Salvage Bilge Pumps.* (11) May 30.
Underwater Construction of Outshore Launching Ways.* E. D. Buel. (13) June 5.
Electric Propulsion for the U. S. S. *New Mexico*.* C. S. Raymond. (From *General Electric Review*.) (19) Serial beginning June 7.
America Flies the Atlantic: The Design and Development of the N.C.-4.* (46) June 7.
German Submarine Diesel Engines. (11) June 13.
Carron Dry Dock at Grangemouth.* (11) June 13.
The Seaplane Carrier *Argus*.* (46) June 14.
British Concrete Shipbuilding: Unit System Construction.* W. Noble Twelvetrees. (11) June 27.
Turbine-Driven Marine Auxiliaries.* (12) June 27.
Crude-Oil Motors *vs.* Steam Engines in Marine Practice.* J. W. Morton. (55) July.
Shipbuilding Equipment and Methods at Fore River: I, Hull Construction Plant. (13) July 3.
Fabricated-Ship Plant Planned for Later General Use.* M. E. Allen. (13) July 10.
Bunkering Big Ships.* J. F. Springer. (46) July 12.
Les Ferry-Boats Militaires Franco-Anglais.* (33) Feb. 22.
Les Appareils de Levage dans les Chantiers de Constructions Navales.* (33) Apr. 5.
Mécanismes Amovibles pour la Propulsion des Navires.* Tayon. (33) Apr. 19.
Motorsegler aus Beton.* (78) Feb. 5.

Mechanical.

The Utilization of Waste Heat from Open-Hearth Furnaces for the Generation of Steam.* Thomas B. Mackenzie. (71) Vol. 98, 1918.
The Standardization of Tests for Refractory Materials.* (Report of Committee of Ceramic Soc.) (71) Vol. 98, 1918.
Automobile Power Plant. G. F. Kettering. (4) Jan.
The Practical Operation of Industrial Boilers. W. E. Snyder. (58) Mar.
A Modern Coke Oven and By-Product Plant.* Drummond Paton. (Paper read before Manchester Geological and Min. Soc.) (57) Apr. 17.
The Dynamical Balance of Recoiling Parts in Heavy Gun Carriages.* G. M. Russell. (11) Apr. 18.

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* Illustrated.

Mechanical—(Continued).

Distribution of Heat, Light and Motive Power by Gas and Electricity. Dugald Clerk. (29) Apr. 18.
Determining Correct Location of Brake Levers.* Walter C. Baker. (From paper read before Soc. of Automotive Engrs.) (120) Apr. 24.
Fordson Tractor Assembly Wholly on Progressive Plan.* J. Edward Schipper. (120) Serial beginning Apr. 24.
King-Bugotti 16-Cylinder Aero Engine.* (120) Serial beginning Apr. 24.
Some Features of Carbonization and Bye-Product Recovery. J. Thorp. (Paper read before Coke-Oven Managers' Assoc.) (66) Apr. 29; (57) May 2.
An Exhaust Steam Turbine Installation.* R. M. Rush. (62) Serial beginning May; (62) June.
A Review of Modern Steam Shovel Practice, with Recommended Procedure.* Llewellyn N. Edwards. (60) May.
Proper Lubrication of Air Compressors.* H. V. Conrad. (Paper read before Compressed Air Soc.) (116) May.
Combustion Considerations of Solid Fuel.* A. D. Williams. (116) May.
G.-L. Low-Temperature Carbonizing Process.* (45) May 1.
New Coke Ovens at the Providence Gas Works.* Edward H. Bauer. (83) Serial beginning May 1.
Steel Works Machinery.* T. W. Hand. (Paper read before Sheffield Soc. of Engrs. and Metallurgists.) (11) Serial beginning May 2.
Air Mileage of Aeroplanes Intended for Long Distances and for Transport.* J. Dennis Coales. (11) Serial beginning May 2.
Fifteen Ovens of Michigan Light Company at Kalamazoo Have Capacity of 1 250 000 Cu. Ft. of High-Grade Gas per Day.* Louis Resnick. (24) May 3.
Armour's Special Testing Equipment. G. F. Gebhardt. (64) May 6.
Specifications for Leather Belting.* H. E. Weightman. (64) May 6.
Fuel Limitations of Tractor Engines. H. L. Horning. (Paper read before Soc. of Automotive Engrs.) (120) May 8.
The Tarrant Triplane.* (12) May 9; (11) May 9.
Diesel Engines Prove Economical at Lincoln.* O. J. Shaw. (17) May 10.
Cost of Fuel for Steam-Electric Stations.* Willis T. Batcheller. (111) May 15.
The Future of Peat as a Fuel.* J. B. C. Kershaw. (45) Serial beginning May 15.
A Service Study of Machine Tool Drives. H. W. Tice. (20) May 15.
Curtiss K-6 and K-12 Aircraft Engines.* (120) May 15.
Winton Diesel Engines.* (120) May 15.
Powdered Fuel for Firing Metallurgical Furnaces and Steam Boilers.* J. S. Atkinson. (Paper read before Sheffield Soc. of Engrs. and Metallurgists.) (22) May 16.
The Stevens Petrol-Electric Vehicle.* (26) May 16.
Dirt in Coal. L. J. Joffray. (Paper read before International Ry. Fuel Assoc.) (45) May 22.
Preparation of Bituminous Coal. Ernst Prochaska. (45) Serial beginning May 22.
Improved Oil-Pressure Regulation in Liberty Engine.* (From Liberty Engine Service *Bulletin No. 8.*) (120) May 22.
Continental Plant Layout Facilitates Production.* (120) Serial beginning May 22.
Flowmeters and the Calibration of Carbureter Nozzles.* G. Smith Clarke. (Abstract of paper read before Inst. of Automobile Engrs.) (120) May 22.
Model Experiments in Aeronautics.* (11) May 23.
Utilizing Mine Waste and Inferior Fuels.* F. Blache. (From *Bulletin* de la Société de l'Industrie Minerale.) (57) May 23.
The Heating and Ventilation of Workshops.* (12) Serial beginning May 23.
Our Trans-Atlantic Dirigible Entry: Some Constructional Details of the U. S. Navy Dirigible C-5. (46) May 24.
Method of Computing Gauge Table for Circular Oil Storage Reservoir with Sloping Side Walls.* E. D. Cole. (86) May 28.
Diesel Engines for Automobile Work.* (120) May 29.
The Ohio Tilted Rotary.* (120) May 29.
Progress in Utilizing Pulverized Fuel.* W. J. Bohan and others. (Progress Report read before International Ry Assoc.) (45) May 29.
Machinery Used in the Stripping of Coal.* S. B. Creamer. (45) May 29.
Factors Influencing the Properties of Silica Bricks.* Alexander Scott. (Abstract of paper read before Refractory Materials Section of Ceramic Soc.) (22) Serial beginning May 30.
The Efficient Compression of Air.* Charles A. Hirschberg. (Abstract from *Power Plant Engineering* and *Compressed Air Magazine.*) (103) May 31.
Development in the Use of Producer Gas.* Earl E. Adams. (Paper read before Am. Drop Forge Assoc.) (62) June.
The Low Pressure Exhaust Steam Turbine.* H. V. Schoepflin. (Paper read before Am. Drop Forge Assoc.) (62) June.

* Illustrated.

Mechanical—(Continued).

Oil-Shales. Dean E. Winchester. **(3)** June.
Mammoth Coke Plant.* Frank F. Marquard. **(116)** June.
How Do You Utilize Your Exhaust Steam? D. O. Tylee. **(116)** June.
An Electrically-Operated Quarry and Plant for Production of Broken Stone at Gary, Ill.* **(67)** June.
Economical Fuel Burning Equipment.* J. G. Worker. **(116)** June.
Suggestions for Correct Boiler Baffling.* A. D. Williams. **(116)** June.
Combustion Control in Mill Boiler Plant.* Robert June. **(116)** Serial beginning June.
Central Station Heating in Detroit.* J. H. Walker. **(55)** June.
Production of Liberty Motor Parts at Ford Plant.* W. F. Verner. **(55)** June.
Economy of Arizona Power Plants Using Oil Fuel.* C. R. Weymouth. **(55)** June.
Air Fans for Driving Generators on Airplanes.* G. Francis Gray and others. **(55)** June.
Rural Gas Distribution. B. Frank Buck. (Paper read before New Jersey Gas Assoc.) **(83)** June 2.
Displacing Natural Gas with Manufactured Gas. John H. Maxon. (Abstract of paper read before Natural Gas Assoc.) **(83)** June 2.
A 400-500 B. t. u. Gas Proposed for Great Britain. (Report read before British Board of Trade.) **(83)** June 2.
Circulation in Water-Tube Boilers.* A. Bement. **(64)** June 3.
Splintering Properties of Airplane Woods.* G. E. Heck. **(120)** June 5.
Effect of Water Injection on Gasoline Engines. **(120)** June 5.
Gear Steels. J. Heber Parker. (Paper read before Am. Gear Mfr.'s Assoc.) **(120)** June 5.
New Coal-Handling Plants for Philadelphia Water-Works.* Harrison R. Cady. **(13)** June 5.
The "Vickers-Vimy" Transatlantic and Commercial Aeroplanes.* **(12)** June 6.
The Effect of a Side-Wind on Interplane Struts.* A. J. Sutton Pippard. **(11)** June 6.
A New Prime Mover of High Efficiency and British Origin.* (Still Engine). Frank E. D. Acland. **(29)** June 6.
The "Vickers-Vimy" Passenger-Carrying Aeroplane.* **(11)** June 6.
The Air Receiver. Frank Richards. **(12)** Serial beginning June 6.
America Flies the Atlantic: The Design and Development of the N. C.-4.* **(46)** June 7.
Pipe-Line Flow Capacities for Natural Gas.* E. O. Hickstein. **(24)** June 7.
Up to 225 000 Cu. Ft. Daily, Stop-End Benches can be Operated with as Little or Less Expense than any Other Type. L. G. Crenshaw. (Paper read before Southern Gas Assoc.) **(24)** June 7.
Boiler-Tube Failures. Waldo Weaver. **(64)** June 10.
Shaft Alignment and Its Importance.* J. Y. Dahlstrend. **(64)** June 10.
Air Weight and Volume Measurement.* Don T. Hastings. **(120)** June 12.
Hydraulically Operated Shell Machines.* P. B. Cochrane. **(72)** June 12.
Two-Stroke Engines for Motorcycles.* E. Tilston. (Paper read before Inst. of Automobile Engrs.) **(120)** June 12.
The Economics of Flight.* H. B. Irving. **(120)** June 12.
The Influence of Hitches and Drawbar Location on Tractor Design.* A. W. Scarratt. **(120)** June 12.
Effects of Wrapping on the Strength of Struts. T. R. C. Wilson. **(120)** June 12.
Heavy Shop Framing for 250-Ton Traveling Crane.* **(13)** June 12.
Specifications of Stock Engines for Passenger Cars, Trucks and Tractors.* **(120)** June 12.
Study of Air Resistance and Air Flow.* H. Levy. **(120)** June 12.
Farm Tractor Design.* Joseph Jandasek. **(120)** Serial beginning June 12.
A New Method of Determining Rate of Flame Propagation.* P. M. Heldt. **(120)** June 12.
Carburetion of Low Grade Fuels.* O. H. Ensign. **(120)** June 12.
Fusibility of Ash from Pennsylvania Coals.* W. A. Selvig and A. C. Fieldner (U. S. Bureau of Mines). **(45)** June 12; **(105)** June 15.
Steam Meters.* **(12)** June 13.
Coxton Coal Mixing Plant, Lehigh Valley R. R. **(18)** June 14.
The Abrasion Meter.* Raymond Francis Yates. **(19)** June 14.
Power Requirements of Rock-Crushing Plants.* Mark H. Reasoner. **(103)** June 14.
Heating of Buildings by Electricity.* V. H. Greisser. (Report read before Idaho Public Utilities Comm.) **(111)** June 15.
Experience with Electric Heating in the Northwest.* J. D. Ross. (Report read before Idaho Public Utilities Comm.) **(111)** June 15.
Gas Meters 10 Years in Service Need Repairing.* H. A. Norton. (Discussion before New England Guild of Gas Mgrs.) **(83)** June 16.
Results from Vertical Retorts at Meriden. **(83)** June 16.
Tentative Code for the Regulation of Refrigeration Plants. (Adopted by Am. Soc. of Refrigerating Engrs.) **(64)** June 17.

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* Illustrated.

Mechanical—(Continued).

Fires in Turbo-Alternators.* (Abstract of Report of Sub-Committee read before National Elec. Light Assoc.) (64) June 17.
Care of Heating and Ventilating Equipment.* Harold L. Alt. (64) June 17.
Preparing Coal Samples for Analysis.* S. W. Parr. (64) June 17.
Alignment Charts for Finding the Dimensions and Volumes of Bumped Heads.* C. H. Berry. (64) June 17.
Refrigerating Plant No. 1, American Expeditionary Forces.* John V. Fisher. (64) June 17.
The Utilization of Gaseous Fuel in Commercial Practice.* F. W. Epworth. (66) June 17.
Cement Joints for Cast-Iron Water and Gas Mains at Vallejo, California. (13) June 19.
The British Eight-Inch Howitzer.* I. William Chubb. (72) Serial beginning June 19.
"Spontaneous Combustion." Watson Smith. (29) June 20.
Emphasizes Need of Pyrometer When Using High Pressure Blast in Water Gas Manufacture. F. L. Weisser. (From paper read before Southwestern Elec. and Gas Assoc.) (24) June 21.
One Hundred Thousand Horse-Power Steam Turbine.* (46) June 21.
Wherein a Joint in the Outlet Pipe from a 2 000 000 Cu. Ft. Holder 18 Ft. from Tank Bottom and a Diver Cleans Out Bottom with Holder Full of Gas.* A. H. Harris, Jr. (24) June 21.
Scavenging in Two-Stroke-Cycle Diesel Engines.* Nicholas M. Trapnell. (64) June 24.
Important and Neglected Features of Tire Maintenance.* A. F. Masury. (13) June 26.
Visualizing the Future Truck. Louis P. Kalb. (Paper read before the Soc. of Automotive Engrs, under title, "The Relation of Motor Truck Ability to the Trend of Design.") (120) June 26.
Novel Features in a Two-Cylinder Marine Set.* (120) June 26.
Late Addition to Youngstown Coke Plant.* (20) June 26.
Report of Divisions as Revised and Approved by Standards Committee.* (Soc. of Automotive Engrs.) (120) June 26.
Load Characteristics of Radio-Thrust Bearing.* F. W. Gurney. (72) June 26.
Flatness Tests at Bureau of Standards.* R. L. Rankin. (72) June 26.
The Hispano-Suiza Airplane Engine.* H. O. C. Isenberg. (72) Serial beginning June 26.
Live-Roller Motors in Steel Works. W. W. Wood. (From article in *Magnet Magazine.*) (22) June 27.
The Measurement of Steam and Water in Power Stations.* W. M. Selvey. (73) June 27.
The Combustion of Powdered Fuel.* J. S. Atkinson. (73) June 27.
Two Newcomen Engines.* (12) June 27.
Description of Automatic Ore Unloader.* (116) July.
Industrial Lighting.* C. E. Clewell. (Paper read before Illuminating Eng. Soc.) (3) July.
Manufacturing Plant of the Providence Gas Co.* Walter M. Russell. (Paper read before Am. Inst. of Chemical Engrs.) (105) Serial beginning July 1.
Exhaust Steam in Water Gas Machines.* Raymond L. Greene. (83) July 1.
Patching of Jamb Leaks in Coke-Oven Brickwork.* R. L. Fletcher. (83) July 1.
Functions of the Ammonia Condenser.* H. J. MacIntire. (64) July 1.
Sudden Peak Loads on Chain-Grate Stokers.* H. F. Ganss. (64) July 1.
Is Rust-Proofing for Trucks Practical? E. T. Birckall. (Paper read before Soc. of Automotive Engrs.) (120) July 3.
An Unconventional British Engine.* (120) July 3.
Moving 60-Ft. Oil Storage Tanks 150 Miles by Water.* A. J. T. Taylor. (96) July 3.
Burning Steam Sizes of Anthracite with or without an Admixture of Soft Coal.* William P. Frey. (From *Bulletin* issued by U. S. Fuel Administration.) (45) July 3.
Great Britain's Giant Bombing Plane. (The Tarrant).* (46) July 5.
Remodeling Suction Gas Mains, Anheuser-Busch Brewery.* Robert H. Karl. (64) July 8.
Tar Disposal in Ford Producer-Gas Plants.* (64) July 8.
Air Lift Pumping.* John Oliphant. (96) July 10.
A Pair of Cams of Unusual Form.* Ellsworth Sheldon. (72) July 10.
A Technical Study of the R-34 Motor Plant.* (120) July 10.
France's Liberty Engine: The Amazing Salmson.* W. F. Bradley. (120) July 10.
The Relative Economy of Freight Transport by Railway and by Motor Truck.* Charles Whiting Baker. (13) July 10.
World's Most Powerful Prime Mover.* A. B. Cole. (96) July 10.
New Heating and Ventilating System for Chicago Schools.* John Howatt. (64) July 15.

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* Illustrated.

Mechanical—(Continued).

Particulars of a 56 000 Sq. Ft. Surface Condenser.* **(64) July 15.**
Utilization of Coke in Europe. A. W. H. Griepe. **(83)** July 15.
Nouveaux Derricks de 3 Tonnes.* **(33)** Mar. 8.
Hangars en Béton Armé pour les Hydravions du Centre Maritime d'Alger.* E. Carret. **(33)** Mar. 24.
Mandrin à Centrage Automatique Système. H. Spillman.* **(33)** Mar. 29.
La Service Automobile Militaire français, son Organisation et son Fonctionnement Pendant la Guerre.* Robert Altermann. **(33)** Apr. 12.
Le Soudage des Verres.* **(33)** Apr. 19.
Remarques sur le Système des Tolérances dans les Constructions Mécaniques.* **(33)** May 3.
Grue à Volée Equilibrée Système Toplis, pour Chantiers Navals.* A. Brillouin. **(33)** May 10.
La Gazéification des Houilles et le Chauffage des Fours. V. Guillermin et M. Gillot. **(33)** May 17.
Zur Regelung der Steuerung der gegenwärtigen Bauarten von Dampfturbinen.* Ernst Blau. **(53)** Serial beginning Oct. 25, 1918.
Ueber Bohrversuche mit Metallen und Legierungen. P. Ludwik. **(53)** Jan. 4.
Die Entwicklung des elektrischen Fördermaschinenantriebes.* W. Philippi. **(41)** Serial beginning Jan. 16.
Schnellaufende Schraubenturbinen und deren wirtschaftlicher Vergleich mit Francisturbinen.* W. Zuppinger. **(107)** Serial beginning Apr. 5.

Metallurgical.

The Chemical Detection of Strain in Iron and Steel by Their Reaction with Nitric Acid.* J. H. Whiteley and A. F. Hallimond. **(71*a*)** Vol. 9, 1918.
An Investigation on the Wearing and Antifrictional Qualities of Cast Iron.* J. E. Hurst. **(71*a*)** Vol. 9, 1918.
The Effects of Cold-Working on the Elastic Properties of Steel.* J. A. Van Den Broek. **(71*a*)** Vol. 9, 1918.
The Influence of Some Elements on the Tenacity of Basic Steel, with a New Formula for Calculating the Maximum Load from the Composition.* Andrew McWilliam. **(71)** Vol. 98, 1918.
Influence of Hot-Deformation on the Qualities of Steel.* Georges Charpy. **(71)** Vol. 98, 1918.
Report on Hardness Testing: Relation Between Ball Hardness and Scleroscope Hardness.* A. F. Shore. **(71)** Vol. 98, 1918.
Some Experiments on the Reaction between Pure Carbon Monoxide and Pure Electrolytic Iron Below the A-1 Inversion.* H. C. H. Carpenter and C. Coldron Smith. **(71)** Vol. 98, 1918.
A Method for the Prevention of Growth in Grey Cast Iron.* J. E. Hurst. **(71)** Vol. 98, 1918.
The Principles of Open-Hearth Furnace Design.* Chas. H. F. Bagley. **(71)** Vol. 98, 1918.
On the Cooling of Steel in Ingot and Other Forms.* J. E. Fletcher. **(71)** Vol. 98, 1918.
A Few Notes on Bosh Tuyeres.* J. S. Hollings. **(71)** Vol. 98, 1918.
Note on the Warping of Steel Through Repeated Quenching.* J. H. Whiteley. **(71)** Vol. 98, 1918.
Phosphorus in Malleable Cast Iron.* J. H. Teng. **(71)** Vol. 98, 1918.
On Magnetic Analysis as a Means of Studying the Structure of Iron Alloys.* Kôtaro Honda. **(71)** Vol. 98, 1918.
On the Rate of Change at 100° C. and at Ordinary Temperatures in the Electrical Resistance of Hardened Steel.* E. D. Campbell. **(71)** Vol. 98, 1918.
The Standardization of Tests for Refractory Materials.* (Report of Committee of Ceramic Soc.) **(71)** Vol. 98, 1918.
The Practical Management of Blast-Furnace Plants in Cleveland. H. G. Scott. (Paper read before Cleveland Inst. of Engrs.) **(22)** Jan. 17.
The Solubility and Stability of Iron Carbide in Cast Iron. J. A. Holden. **(22)** Apr. 18.
Magnesium and Its Alloys: Its Use for Aero-Engines and Motor Cars. **(12)** Apr. 25.
Using Powdered Coal in Forge Furnaces.* Charles Longenecker. **(62)** May.
Outlining Cost Systems for Forge Plants. C. Oliver Wellington. **(62)** May.
The Production of Hot Pressed Brass Parts.* Edmund W. Zeh. **(62)** May.
Saving Equipment by Thermit Welding. W. R. Hulburt. **(62)** May.
Autogenous Welding at Albuquerque.* H. Louis Hahn. **(25)** May.
Utilizing Scrap in the Drop Forge Plant.* H. M. Arhamala. **(62)** May.
Metallurgical Considerations of Duplexing. Richard S. M'Coffery. **(116)** Serial beginning May.
The Vapor Tensions of the Metals. J. W. Richards. **(3)** May.

* Illustrated.

Metallurgical—(Continued).

Application of the Sand-Blast.* H. D. Gates. (Paper read before Newark Foundrymen's Assoc.) (**20**) May 1.
Treatment of Cuprodescloizite for Extraction and Recovery of Vanadium, Lead and Copper.* J. E. Conley. (**105**) May 1.
Making Cold-Drawn Screw and Shaft Stock.* Robert I. Clegg. (**20**) May 1.
The Technique of Arc Welding.* F. A. Anderson. (**111**) May 1.
Flaky Fractures and Their Possible Elimination.* Haakon Styri. (**105**) May 1.
Metallic Coatings for Rust-Proofing Iron and Steel.* Henry S. Rawdon and others. (**105**) Serial beginning May 1.
X-Ray Examination as Applied to the Metallurgy of Steel.* Robert Hatfield and others. (Abstract of paper read before Faraday Soc. and Röntgen Soc.) (**22**) May 2.
Automatic Ore Handling Plant.* (**22**) May 2.
Steel Works Machinery.* T. W. Hands. (Paper read before Sheffield Soc. of Engrs. and Metallurgists.) (**11**) Serial beginning May 2.
The Electrolytic Refining of Silver and Gold.* George G. Griswold. (Paper read before Am. Electrochemical Soc.) (**16**) May 3.
Economics of Concentration.* A. P. Watt. (**16**) May 3.
Manganese Alloys in Open-Hearth Steel Practice. Samuel L. Hoyt. (**19**) May 3.
Manufacturing Non-Ferrous Metal Articles.* (**20**) May 8.
Copper-Smelting Slag from the Microscopic and Chemical Point of View.* C. G. Maier and G. D. Van Arsdale. (**16**) May 10.
Determination of Uranium, Zirconium, Chromium, Vanadium and Aluminium in Steel.* Charles Morris Johnson. (**105**) Serial beginning May 15.
A Proposed Metallurgical Process for the Treatment of Vanadinite for the Recovery of Lead and Vanadium. J. E. Conley. (**105**) May 15.
Sintering Zinc Residues.* K. Stock. (**105**) May 15.
Fundamental Principles to be Considered in the Heat Treatment of Steel. R. A. Hayward. (**105**) May 15.
Steel Mill Practice and Heat Treatment.* A. F. MacFarland. (Abstract of paper read before Am. Steel Treaters' Soc.) (**20**) May 22.
The Metallurgy of Copper.* Thomas H. A. Eastdick. (**19**) May 24.
Melting of Non-Ferrous Metals and Alloys.* E. F. Collins. (Abstract of paper read before Cleveland Eng. Soc.) (**27**) May 24.
Non-Metallic Impurities in Steel.* Henry D. Hibbard. (Paper read before Am. Iron and Steel Inst.) (**20**) May 29.
Charging Raw Material into Blast Furnaces.* J. A. Mohr. (Paper read before Am. Iron and Steel Inst.) (**20**) May 29; (**116**) June.
The American Bridge Co.'s Forge Plant.* C. J. Walker. (**20**) May 29; (**116**) June.
Electrically Heated Soaking Pit.* Thaddeus F. Bailey. (Paper read before Am. Iron and Steel Inst.) (**20**) May 29; (**116**) Serial beginning June.
On the Solid and Liquid States of Steel. Cosmo Johns. (Paper read before West of Scotland Iron and Steel Inst.) (**11**) May 30.
A New Type of Recuperative Furnace.* Walter Rosenhain and E. A. Coad-Pryor. (Paper read before Ceramic Soc.) (**11**) May 30.
Mechanical Charging of Silver Lead Blast-Furnaces.* L. D. Anderson. (Abstract from *Journal* of Utah Soc. of Engrs.) (**103**) May 31.
Modern Forge Plant for Ordnance Work.* C. J. Walker. (Paper read before Am. Iron and Steel Inst.) (**62**) June.
Fusion Welding as Applied to Forge Work.* S. W. Miller. (**62**) June.
Notes on Welding Systems.* James Caldwell. (Paper read before Inst. of Engrs. and Shipbuilders in Scotland.) (**2**) June.
Sand Blasting Forgings *vs.* Pickling.* R. R. Shuman. (From paper read before Am. Drop Forge Assoc.) (**62**) June.
The Reconstructed Sizer Forger Plant.* (**62**) June.
Unique Pump House for Blast Furnace.* (**116**) June.
Government Steel Plant.* S. W. Stratton. (Paper read before Am. Iron and Steel Inst.) (**116**) June.
Methods for Obtaining Better Forgings. W. C. Peterson. (Paper read before Am. Drop Forge Assoc.) (**62**) June.
Report of Standardization Committee.* (Am. Drop Forge Assoc.) (**62**) June.
Temperature Observations on Heating, Quenching and Drawing of a Large Steel Forging.* O. A. Knight and F. F. Hansen. (**105**) June 1.
Flotation Experiments on Hardwood Tar Oils.* L. F. Hawley and O. C. Ralston. (**105**) June 1.
Flotation for the Practical Mill Man. Frederick G. Moses. (**105**) June 1.
Heat Treatment of Alloy Steel. K. A. Juthe. (**72**) June 5.
Chromium in Steel. G. L. Kelley and W. C. Wright. (**20**) June 5.
New Type Electric Furnaces.* A. M. Clark. (**20**) June 5; (**116**) July.
New Features in Heat Treating Plant.* (**20**) June 5.
Gear Steels. J. Heber Parker. (**120**) June 5.

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* Illustrated.

Metallurgical—(Continued).

800-Ton Blast Furnace Plant at the Park Gate Works, Rotherham, and the Staveley Works, Chesterfield. (22) June 6; (12) June 6.
Some Zinc and Aluminum Alloys.* Walter J. May. (From *English Mechanics* and *World of Science.*) (19) June 7.
Recovery of Copper from Flotation by Leaching. Percy R. Middleton. (103) June 7.
Old Foundry Replaced by New.* (20) June 12.
The Influence of Size on Heat-Treating.* E. J. Janitzky. (*Journal* of Am. Steel Treaters' Soc.) (72) June 12.
Welding Mild Steel.* H. M. Hobart. (Report of Committee of U. S. National Research Council and Emergency Fleet Corporation.) (11) Serial beginning June 13.
A Large Spot-Welding Machine.* (12) June 13.
Plastic Arc System of Welding.* J. O. Smith. (18) June 14; (45) June 26.
Alloy Steels for Helmets and Armor.* John A. Coyle. (105) June 15.
Nodulizing Flotation Concentrates on a Rotary Kiln with Powdered Coal.* Robert M. Draper. (105) June 15.
Commercial Feasibility of Electric Smelting of Iron Ores in British Columbia.* (Excerpts from *Bulletin* issued by British Dept. of Mines.) (105) June 15.
Effect of Sodium Chloride on Blue-Powder Formation.* Reginald S. Dean. (105) June 15.
Notes on the Influence of Certain Variables Associated with the Anneal of Cold-Worked Alpha Brass.* Arthur Phillips and George C. Gerner. (105) June 15.
Electricity in the Making of Copper Wire.* (111) June 15.
The Use of X-Rays in Metallurgy.* Engene Schneider and others. (Abstracts of papers read before Faraday Society and Roentgen Society.) (20) June 19.
Manganese Special Work Repaired by Welding.* Julian M. Scott. (17) June 21.
Steel Wheels by a New Process.* E. F. Cone. (46) June 21.
The Properties of High Speed Steel.* G. J. Horvitz. (From paper read before Am. Steel Treaters' Soc.) (20) June 26.
A New Electric Rotating Brass Furnace.* Carl H. Booth. (Abstract of paper read before Am. Inst. of Chemical Engrs.) (20) June 26.
Factors in the Economical Production of Electric Steel. J. A. Holden. (22) June 27.
The Roasting and Magnetic Separation of Wisconsin Zinc Ores.* E. G. Dentman. (16) June 28.
Notes on Screening Practice.* John Bland. (16) June 28.
Electric Furnace Operation at Buffalo.* (27) June 28.
Shafting and Belting.* Robert S. Lewis. (16) June 28.
Design of Small Metallurgical Mills.* Herbert A. Megraw. (16) June 28.
Notes on Flotation.* Joseph P. Ruth, Jr. (16) June 28.
An Outline for Flotation Test Work. H. L. Hazen. (16) June 28.
Continuous Overflow and Its Effect on the Slag Loss of Reverberatory Furnaces. Oliver E. Jager. (103) June 28.
Continuous Furnace for Heating Forgings.* (116) July.
Electrical Cleaning of Blast Furnace Gas.* W. H. Gellert. (116) July.
Methods of Blast Furnace Charging. Harry S. Braman. (116) July.
Research Work on Malleable Iron.* Enrique Touceda. (55) July.
New and Rapid Apparatus for Electrochemical Analysis.* J. T. King. (105) July 1.
Rocking Electric Arc Furnace.* H. M. St. John. (Extracts from paper read before Am. Inst. of Chemical Engrs.) (105) July 1.
Treatment of Complex Speisses.* Paul Papencordt. (105) July 1.
Utilization of Electric Brass Furnaces.* H. W. Gillett. (Extracts from paper read before Am. Inst. of Chemical Engrs.) (105) July 1.
Some Facts About Monel Metal.* Hugh R. Williams. (64) July 1.
Electric Furnaces of the Resistance Type.* T. E. Bailey. (Extracts from paper read before Am. Inst. of Chemical Engrs.) (105) July 1.
Heat Treatment of Railroad Materials.* C. B. Bronson. (From paper read before Am. Steel Treaters' Soc.) (20) July 3; (18) July 12.
Developments in Lake Superior Milling.* C. H. Benedict. (16) July 5.
How the Inland Steel Co. Met War Demand. (20) July 10.
Desulphurizing in the Pig Iron Mixer.* L. Blum. (From *Stahl und Eisen.*) (20) July 10.
Blast-Furnace Explosions.* B. B. Hood. (16) July 12.
Considerations on the Treatment of Flotation Concentrate. Oliver E. Jager. (103) July 12.
Refining Flake Graphite for Crucible Use.* Frederick G. Moses. (U. S. Bureau of Mines.) (16) July 12.
The Chloride-Volatization Process. Blamey Stevens. (103) July 12.
Evolution of the Lynite Laboratories.* (20) July 17.

* Illustrated.

Metallurgical—(Continued).

Relative Size in Heat Treatment: Practical Examples on Various Sizes of Carbon and Alloy Forgings—Results in Hollow Material—Effect on Hardness.* T. G. Straub. (20) July 17.

La Radiographie des Métaux, l'Emploi des Rayons X pour Rechercher les Défauts Internes des Pièces Métalliques.* Ch. Dantin. (33) Mar. 8.

Train Blooming à Commande Electrique; Système Westinghouse.* (33) Mar. 22.

Les Dévastations allemandes dans les Usines Sidérurgiques de Meurthe-et-Moselle.* Auguste Pawlowski. (33) Mar. 29.

Le Train de Laminoir à Toles de la Lukens Steel Co., à Coatesville (Pennsylvanie, E.-U.)* F. Coleru. (33) Apr. 19.

Nouveau Type de Laminoir à Cage Basculante, Système Fawell.* (33) May 31.

Elektrotechnische Anwendungen des Schoopschen Metallspritzveifahrens. (41) Jan. 16.

Ueber die Erzeugung von Elektrosthahl für Stahlformguss im basisch zugestellten Héroultofen bei Verwendung von festem Einsatz. Berthold Schudel. (107) Serial beginning Mar. 1.

Military.

Technical Engineering Details of the Hindenburg Line in the Sector of Attack of the II Army Corps.* G. P. Pillsbury. (100) Mar.

The World's Biggest Building Project.* (Cantonments.) Arthur J. Widmer. (115) Mar.

Railway Artillery.* E. D. Campbell. (115) Mar.; (18) June 14.

The Dynamical Balance of Re-oiling Parts in Heavy Gun Carriages.* G. M. Russell. (11) Apr. 18.

The Operation and Maintenance of Utilities at Army Camps and Cantonments.* George A. Johnson. (109) May.

Design and Tests of Highly Efficient Air-Lift Installation at Fort Bliss, Texas.* J. F. Brown. (13) June 5.

The British Eight-Inch Howitzer.* I. William Chubb. (72) Serial beginning June 19.

Storing and Handling High Explosives During the War.* G. C. Munoz. (13) June 26.

Light Railway Engineering in Modern Warfare.* C. H. R. Fuller. (96) July 3.

American Engineers Make Records in Bridging the Rhine.* James M. Farrin and Sam H. Andrews. (13) July 17.

Building the New Orleans Army Supply Base.* (13) July 17.

Le Développement des Fabrications de Guerre en France de 1914 à 1918.* (33) Mar. 29.

Les Mines, Sous Marines.* (33) May 10.

Entrepots Militaire due Port de New-York: La "Base" de Brooklyn.* P. Calfas. (33) May 17.

Die Nutzbarmachung der Kriegsmaterialien für den Frieden. Max Ried. (53) Oct. 18, 1918.

Mining.

Digest of the First Report of the Mine Rescue-Apparatus Research Committee.* David Penman. (106) Apr.

A Method of Determining the Magnetic Meridian as a Basis for Mining Surveys.* T. Lindsay Galloway. (106) Apr.

The Chance Acetylene Safety-Lamp.* William Maurice. (106) Apr.

Methane Accumulations from Interrupted Ventilation.* H. I. Smith and R. J. Hamon. (U. S. Bureau of Mines.) (57) Apr. 17.

Comparative Working Costs of Electrical and Compressed-Air Coal-Cutting Machines (Longwall) with Increased Outputs Over Hand Hewing. F. A. Hale. (Abstract of paper read before Assoc. of Min. Elec. Engrs.) (22) Apr. 18.

Routine Examinations and Testing of Colliery Electrical Apparatus.* L. Fokes. (57) Apr. 25.

Subsidiary Electric Haulages. A. Sharp. (Paper read before Assoc. of Min. Elec. Engrs.) (22) Apr. 25.

The Accurate Determination of Carbon Monoxide in Gas Mixtures.* J. Ivon Graham. (Paper read before Soc. of Chemical Industry.) (57) Apr. 25.

An Electrically-Driven Winding Equipment.* (26) Apr. 25; (22) May 16.

Steel Mine Ties.* R. B. Woodworth. (45) May 1.

Underground Coal-Loading Machinery.* E. N. Zern. (Abstract of paper read before Coal Min. Inst. of America.) (45) May 1.

Storage of Powder and Explosives at Coal Mines.* E. M. Kimball. (45) May 1.

New Coal Tipple at a Virginia Operation.* C. Sharon. (45) May 1.

* Illustrated.

Mining—(Continued).

Automatic Reclosing Circuit Breakers in Mine Service.* E. C. Raney. (45) May 1.
New Tipple of the Granby Consolidated Mining, Smelting & Power Co.* F. E. Mueller. (45) May 1.
Coal Transportation by Aerial Tramway.* F. W. Grice. (45) May 1.
The Internal Corrosion of Cables.* Wm. Fleet Robertson. (103) May 3.
Recovery of Pyrite from Washery Refuse.* E. A. Holbrook. (45) May 8.
Inclined Plane of the Union Mining Co.* U. U. Carr. (45) May 8.
Economies in a Mine Power Plant.* J. A. Carruthers. (64) May 13.
Preservation of Mine Timber.* Noah Williams. (Paper read before Manchester Geological Soc.) (57) May 16; (22) May 16.
The Mauss Centrifugal Separators.* E. M. Weston. (16) May 17.
Reserve Coal Deposits Are Blocked Out at Government Mine at Eska, Alaska.* Sumner S. Smith. (From *Alaska Railroad Record.*) (45) May 22.
Coal Mine Ventilation Motors.* H. W. Chadbourne. (Abstract of article from *General Electric Review.*) (45) May 29.
Ironstone Mining in the Midlands. H. K. Scott. (From lecture given at Royal School of Mines.) (22) May 30.
Oiling Mine-Cables in Place.* Wm. Fleet Robertson. (Paper read before Canadian Min. Inst.) (103) May 31.
Know Your Battery Better. J. H. Tracy. (Paper read before Illinois Min. Inst.) (45) June 5.
Coal-Stripping Operations in Ohio.* J. B. Creamer. (45) June 5.
Method Employed in Working the Crescent Mine.* Ralph W. Mayer. (45) June 5.
Car Dumpers.* James A. Jackson. (From *General Electric Review.*) (16) June 7.
Coal Pyrite Resources of Tennessee.* E. A. Holbrook and Wilbur A. Nelson. (From "The Resources of Tennessee.") (45) June 12.
Reline Mine Shaft on Steep Slope with Concrete. (13) June 12.
Vesta Coal Co.'s Modern System of Mine Haulage.* Ralph W. Mayer. (45) June 12.
Anthracite Mining Costs.* R. V. Norris. (45) June 19.
Sealing Up Old or Abandoned Workings in Gaseous Mines. C. Thompson. (Paper read before Illinois Min. Inst.) (45) June 19.
A Peculiar Experience in Shaft-Sinking.* Arthur Jarman. (103) June 21.
Use of Concrete in Underground Works.* (From *Chemical Engineering and Mining Review.*) (16) June 21.
Sinking and Concreting Mine Shaft 936 Ft. Deep.* Richard L. Russell. (13) June 26.
Underground Motor Repair Shop.* Ralph W. Mayer. (45) June 26.
The Importance of Rail Bonding. (Mines.) E. Steck. (45) June 26.
Illinois Coal Mine Electrified Throughout.* (27) June 28.
Sealing Water in California Oil Fields.* Seth S. Langley. (16) July 5.
Electric Hoisting Equipment at the Butte & Superior Mine.* Oliver E. Jager. (103) July 5.
Electrical Transmission of Power in and About Coal Mines. S. W. Farnham. (Abstract of paper read before Illinois Min. Inst.) (45) July 10.
Modern Shaft Mine at Amsterdam, Ohio.* Jack L. Ball. (45) July 10.
Electric Blasting Equipment.* L. D. Rowell. (16) July 12.

Miscellaneous.

Final Report of the Committee on Depreciation.* (Am. Water Works Assoc.) (59) Mar.
A Method of Determining the Magnetic Meridian as a Basis for Mining Surveys.* T. Lindsay Galloway. (106) Apr.
The Accurate Determination of Carbon Monoxide in Gas Mixtures.* J. Ivon Graham. (Paper read before Soc. of Chemical Industry.) (57) Apr. 25.
Outlining Cost Systems for Forge Plants. C. Oliver Wellington. (62) May.
The Oxidation of Ammonia.* W. S. Landis. (Paper read before Am. Electrochemical Soc.) (105) May 1.
Copper-Smelting Slag from the Microscopic and Chemical Point of View.* C. G. Maier and G. D. Van Arsdale. (16) May 10.
Controlling Production in a Motor Plant.* Charles Lundberg. (20) May 15.
Industrial Air Conditions.* J. Esten Bolling. (Abstract of paper read before Cleveland Eng. Soc.) (117) May 15.
Photography in Research.* Arthur G. Eldredge. (105) May 15.
The Oxidation of Ammonia.* (105) May 15.
Rubber as a Colloid. D. F. Twiss. (Paper read before Soc. of Chemical Industry.) (19) May 17.
Methods and Costs of Stump Removal in Land Clearing.* (*Bulletin* issued by Univ. of Wisconsin.) (86) May 21.
The Cost Accounting System of Construction Division, U. S. Army.* C. W. Pinkerton. (86) May 21.

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* Illustrated.

Miscellaneous—(Continued).

Methods Used in Aëro-Photographic Mapping.* **(13)** May 22.
Present Status of Photographic Mapping from the Air. J. B. Mertie. **(13)** May 22.
The Present Status of Nitrogen Fixation.* Alfred H. White. (Abstract of paper read before Am. Inst. of Chemical Engrs.) **(19)** May 24.
Use of Army Gas Masks in Atmosphere Containing Sulphur Dioxide.* A. C. Fieldner and S. H. Katz. (U. S. Bureau of Mines.) **(105)** June 1; **(103)** June 7.
The Oxidation of Ammonia. J. R. Partington. (Paper read before King's College.) **(19)** June 7.
Making the Universal Reagent: The Manufacture of Sulphuric Acid by the Chamber Process. T. R. Horney. **(19)** June 14.
The Chemistry and Constitution of Coal.* A. C. Fieldner. (Paper read before Kentucky Min. Inst.) **(45)** June 25.
Graphical Differentiation and Integration.* Theodore R. Running. (From *Michigan Technic.*) **(86)** June 25.
General Principles of Industrial Lighting.* (National Safety Council.) **(86)** June 25.
Storing and Handling High Explosives During the War.* G. C. Munoz. **(13)** June 26.
The United States Government Chlorine-Caustic Soda Plant at Edgewood Arsenal, Edgewood, Maryland.* Samuel M. Green. **(105)** July 1.
Production et Mesure des Vides Elevés. **(33)** Feb. 15.
Les Besoins de la France en Bois Communs et les Ressources de nos Fôrets Coloniales. **(33)** Feb. 22.
La Réglementation Nationale et Internationale de la Durée du Travail. Paul Razous. **(33)** Mar. 8.
Les Principaux Composés Organiques Dérivés de l'Acétylène; Synthèses Industrielles de l'Alcool, de l'Acide, de l'Anhydride et des Ethers Acétiques, du Butadiène, etc.* D. Florentin. **(33)** Serial beginning Mar. 15.
L'Orientation Professionelle des Blessées de la Guerre.* Paul Razous. **(33)** May 17.
Erddruck bei rückwärtig begrenzter Hinterfüllung.* Max Buchwald. **(78)** Feb. 5.
Wissenschaftliche Betriebführung. Victor Frey. **(107)** May 24.

Municipal.

Notes on Grading and Planting Plans for Government Housing Projects. H. V. Hubbard. **(119)** Apr.
Factors Governing Selection of Industrial Site. Harland Bartholomew. **(13)** May 1.
The Relation of Sunlight to Town Planning. H. L. Seymour. (From paper read before Royal Astronomical Soc.) **(86)** May 7.
Municipal Engineers and Problems of Reconstruction. E. J. Elford. **(114)** May 24.
Municipal Works in the County Borough of Bournemouth.* F. P. Dolamore. **(114)** May 24.
The Zone Fare in Practice—Dublin.* Walter Jackson. **(17)** Serial beginning May 31.
A Solution of the Housing Problem in the United States.* Milo Hastings. **(6)** June.
Housing Activities About the World. **(6)** June.
Some Engineering Problems of Regional Planning. Morris Knowles. (Abstract of paper read before National Conference on City Planning.) **(13)** June 12.
La Ville de Genève, sa formation et son développement futur.* Camille Martin. **(107)** Apr. 5.
Indeen-Wettbewerb zu einen Bebauungs plan der Stadt Biel und ihrer Vorortgemeinden, Nidau, Madretsch, Mett, Brügg und Port.* **(107)** Serial beginning Mar. 15.
Wettbewerg für eine Gartenstadt der Firma Piccard, Pictet & Cie. in Aire bei Genf.* **(107)** Serial beginning Apr. 26.

Railroads.

Maintenance of Freight Equipment. H. L. Shipman. **(61)** Feb. 17.
Timber Preservation. H. S. Sackett. **(61)** Feb. 17.
Mechanical Stoking of Locomotives.* W. S. Bartholomew. **(61)** Mar.
A Technical Description of the British Light Railways in France.* B. W. Guppy **(100)** Mar.
Railway Artillery.* E. D. Campbell. **(115)** Mar.; **(18)** June 14.
Electrification of Main Line Railroads.* W. B. Potter and S. T. Dodd. **(61)** Apr. 21.
Pulverized Fuel Locomotive.* **(12)** Apr. 25.
Railway Electrification. John Murphy. **(5)** May.
The Economics of Electric Operation of Railways. W. G. Gordon. **(5)** May.
Storage Battery Cars for Use in Yucatan.* **(25)** May.
The Effect of Gradients on Train Resistances.* H. C. Webster. **(21)** May.
Creosote Treatment of Car Timbers.* **(25)** May.

* Illustrated.

Railroads—(Continued).

Standard 4-6-2 Type Locomotives.* **(25)** May.
Overcoming Neglected Maintenance in a Terminal. W. F. Rench. **(87)** May.
Autogenous Welding at Albuquerque.* H. Louis Hahn. **(25)** May.
Checking the Service of Treated Ties.* **(87)** May.
Treating Montana Waters.* C. Herschel Koyl. **(87)** May.
Draft Gear Test Demonstrations.* **(25)** May; **(15)** May 2; **(18)** May 3.
Railroad Electrification.* F. H. Shepard. **(5)** May.
Line Revision on Cincinnati Southern Railroad.* **(13)** May 1.
Reinforced Concrete Framed Railway Abutments.* Albert M. Wolf. **(117)** May 1.
Brown Boveré Locomotives for the Swiss Federal Railways.* J. Buchli. **(11)** Serial beginning May 2.
Novel Features in New D. & R. G. Freight Terminal.* **(15)** May 2.
Steel Car Repair Shop, New York Central R. R.* **(18)** May 3.
History and Use of Easement Curves for Railroads. Philip O. Macqueen. **(13)** May 8.
New York Central R. R. Engine Terminal, Gardenville, New York.* **(18)** May 10.
Three-Cylinder Locomotives.* H. Holcroft. **(12)** May 16.
The Wind Resistance on a Train.* C. F. Dendy Marshall. **(12)** May 16.
Supply and Transmission for Modern Railway Signalling.* A. E. Tattersall. **(21)** May 21.
Damage to Rail by Flat Spots on Freight Car Wheels. **(86)** May 21.
Using Modern Appliances in Track Construction.* **(17)** May 24.
Glenwood Shop Improvements, Baltimore & Ohio R. R. **(18)** May 24.
General Solution of Problems in Railway Compound Curves.* Antonio Llano. **(13)** May 29.
Lame Engines and Their Effect on Fuel Consumption. J. W. Hardy. (Paper read before International Ry. Fuel Assoc.) **(15)** May 30.
Missouri Pacific Saves $279 843 by Water Treatment.* R. C. Bardwell. **(15)** May 30.
The Effect of Reducing Exhaust Nozzles to Overcome Front End Air Leaks. F. P. Roesch. (Paper read before International Ry. Fuel Assoc.) **(15)** May 30; **(25)** July.
Rectangular Engine House, Long Island R. R.* L. U. Morris. **(18)** May 31.
Pacific Type Locomotive, Lehigh Valley R. R. **(18)** May 31.
C. P. R. Shop Production Methods.* E. T. Spidy. **(25)** June.
Locomotive Repair Shop Output.* Henry Gardner. **(25)** June.
New York Central Steel Car Shop.* **(25)** June.
The New B. & O. Shops at Glenwood.* **(25)** June.
A Turntable of Unique Design.* **(25)** June; **(15)** June 13.
Erie Railroad has Installed Freight Handling Equipment.* **(117)** June 1.
Derails and Where They Should be Used. **(15)** June 6.
Oerlikon Locomotives for the Swiss Federal Railways.* **(11)** June 6.
Concrete Tunnel Lining by Steam Jet.* **(18)** June 7.
When Freight Cars Bump.* J. Hammond Smith. **(46)** June 7.
Illumination of Toledo & Ohio Central Engine Terminal at West Columbus, O.* R. E. Rice. **(18)** June 7.
Regenerative Direct-Current Electric Railways. E. Austin. **(26)** June 13.
A New Locomotive Repair Shop Built for the B. & O.* **(15)** June 13.
Branch Line Operation with Self-Propelled Motor Cars.* H. W. Protzeller. **(17)** June 14.
Electric Locomotives of Moderate Weight and Power.* A. B. Cole. **(17)** June 14.
Methods Used in Third-Rail Bonding.* G. H. McKelway. **(17)** June 14.
Types of Third-Rail Used in Railway Electrification.* **(17)** June 14.
Fitting the Electric Locomotive to Its Load. A. H. Babcock. (Abstract of paper read before the Pacific Ry. Club.) **(17)** June 14.
New York Central's Latest Motor Cars.* **(17)** June 14.
Unit Steam Railway Motor Car.* **(18)** June 14; **(15)** June 18.
Erie Avenue Engine Terminal, Philadelphia & Reading Ry.* **(18)** June 14.
The Toronto Terminal Railway Co.'s New Station.* H. A. Gardner. **(117)** June 15.
P. R. R. Maximum Tonnage Hopper and Gondola Cars.* **(15)** June 18; **(18)** July 12.
Report of Committee on Brake Shoe and Brake Beam Equipment.* (Am. Ry. Assoc.) **(15)** June 19.
Big Four Increases Capacity at Congested Points.* **(15)** June 20.
P. R. R. General Utility Express and Baggage Car.* **(15)** June 20.
Report of Committee on Welding Truck Side Frames, Bolsters and Arch Bars.* (Am. Ry. Assoc.) **(15)** June 20 (Daily ed.).
Report of Committee on Specification and Tests for Materials (M. C. B.).* (Am. Ry. Assoc.) **(15)** June 20 (Daily ed.).
Report of Committee on Car Wheels.* (Am. Ry. Assoc.) **(15)** June 20 (Daily ed.).
Report of Committee on Depreciation for Freight Cars. (Am. Ry. Assoc.) **(15)** June 20 (Daily ed.).

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* Illustrated.

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Report of the Committee on Draft Gears.* (Am. Ry. Assoc.) (15) June 20 (Daily ed.).
Car Performance from the Engineer's Office to the Track.* C. W. Squier. (17) June 21.
Report of the Standing Committee on Loading Rules.* (Am. Ry. Assoc.) (15) June 21.
Report of the Standing Committee on Safety Appliances.* (Am. Ry. Assoc.) (15) June 21.
Report of Committee on Car Construction.* (Am. Ry. Assoc.) (15) June 21.
Report of Committee on Car Trucks.* (Am. Ry. Assoc.) (15) June 21.
Report of Train Lighting and Equipment.* (Am. Ry. Assoc.) (15) June 23.
Report of the Committee on Tank Cars.* (Am. Ry. Assoc.) (15) June 23.
Report of Committee on Mechanical Stokers.* (Am. Ry. Assoc.) (15) June 24.
Report of Committee on Fuel Economy and Smoke Prevention.* (Am. Ry. Assoc.) (15) June 25.
Carbonization in Valve Chambers and Cylinders of Superheated Steam Locomotives.* F. P. Roesch. (Paper read before Am. Ry. Assoc.) (15) June 25; (18) July 5.
Report of Committee on Superheated Locomotives. (Am. Ry. Assoc.) (15) June 25.
Report of Committee on Locomotive Headlights.* (Am. Ry. Assoc.) (15) June 25.
Report of Committee on Specification and Tests for Materials (A. R. M. M.).* (Am. Ry. Assoc.) (15) June 25.
Drawbar Pull-Speed-Cut-Off Calibration as an Adjunct to Efficiency Locomotive and Train Operation.* B. B. Milner. (Paper read before Am. Ry. Assoc.) (15) June 25; (18) June 28.
Combustion Chambers.* F. F. Gaines. (15) June 26.
Design, Maintenance and Operation of Electric Rolling Stock.* (Abstract of Report read before Am. Ry. Assoc.) (15) June 26.
Use of Bronze for Valve Snap Rings and Piston Surfaces, and Bull Rings in Large Cylinders.* C. E. Fuller. (Paper read before Am. Ry. Assoc.) (15) June 26; (18) June 28.
Air Consumption of Locomotive Auxiliary Devices.* (Abstract of Report read before the Air Brake Assoc.) (25) July.
Box Cars for Chilean Railway.* (25) July.
C. C. C. & St. L. 0-8-0 Switchers.* R. W. Retterer. (25) July.
Constructing a Track Layout in Close Quarters.* W. F. French. (87) July.
Limit of Wear for Steel Wheels.* (25) July.
The Longitudinal Disturbing Forces in Locomotives.* Edward L. Coster. (25) July.
Master Boiler Makers' Convention: Reports and Discussions.* (25) July.
Standard Light Mountain Type.* (25) July.
The Air Compressor in Maintenance Work.* Walter P. Burn. (87) July.
Engine Terminal Improvements: Pennsylvania Lines West.* (13) July 3.
Heat Treatment of Railroad Materials.* C. B. Bronson. (From paper read before Am. Steel Treaters' Soc.) (20) July 3.
Light Railway Engineering in Modern Warfare.* C. H. R. Fuller. (96) July 3.
Grand Trunk 0-6-0 Type Switching Locomotives.* (15) July 4.
Utility Express Car of the Pennsylvania Railroad. (18) July 5.
Practices and Tendencies in Japanese Electric Railway Transportation.* Shiro Sano. (17) July 5.
The Relative Economy of Freight Transport by Railway and by Motor Truck.* Charles Whiting Baker. (13) July 10.
Union Station is Rebuilt Without Interrupting Traffic.* (13) July 10.
Extensive Electrification Proposed for Sweden.* (15) July 11.
Illinois Central Will Build New Chicago Terminal.* (15) July 11.
Methods of Observing and Analyzing Passenger Traffic.* R. H. Horton. (17) July 12.
Proposed New Passenger Terminal in Chicago.* (18) July 12.
Narrow-Gage Railway Operation at Munition Plant.* James A. Silsbee. (13) July 17.
Opening Old Railroad Fill Reveals Reasons for Track Trouble.* R. Reimann. (13) July 17.
Deux Questions Intéressant les Réseaux d'intérêt Local Après la Guerre: 1° Formule d'Explotation à Coefficients Variables; 2° Réduction des Opérations de Transbordement.* Claise. (43) Jan.
L'Etat Actuel et l'Avenir de nos Chemins de Fer d'Intérêt Local; les Chemins de Fer Agricoles. G. Mangin. (33) Serial beginning Feb. 15.
Dispositifs pour le Raccourcissement des Traversées-Jonctions.* A. Goupil. (33) Mar. 15.
L'Etat Actuel des Chemins de Fer Chinois.* G. Bouillard. (33) Apr. 5.
L'Electrification des Chemins de Fers français, sa Répercussion sur les Services Téléphoniques et Télégraphiques.* P. Letheule. (33) Serial beginning Apr. 26.

* Illustrated.

Railroads—(Continued).

L'Emploi du Charbon Pulvérisé sur les Locomotives.* E. Lassueur. (33) May 3.
La Reconstruction de la Gare de Weimar (Saxe).* A. Goupil. (33) May 10.
Die Kohlennot und die Elektrisierung der Bahnen. (53) Jan. 3.
Probleme im Lokomotivbau und-betrieb.* R. Sanzin. (53) Serial beginning Jan. 4.
Zur Neuordnung der deutschösterreichischen Staatsbahnverwaltung. Bruno R. v. Enderes. (53) Jan. 31.
Tunnelbau unter Wasser.* A. Haag. (40) Feb. 1.
Der Bau der Bagdadbahn im Lichte der Kriegswirtschaft.* Walter Morf. (107) Serial beginning Feb. 22.
Akkumulatoren-Verschiebelokomotive mit Windwerk.* S. Abt. (107) Mar. 22.
Die Elektrifizierung der Schweiz. Bundesbahnen. E. Huber-Stockar. (107) Serial beginning Mar. 29.

Railroads, Street.

Six Years of Rapid-Transit Progress in New York.* D. L. Turner. (13) May 1.
Post-Payment Center-Exit Car in Philadelphia.* (17) May 3.
Chicago Rehabilitation Track Standards Prove Successful.* (17) May 3.
Safety Cars in Gary Make Jitneys Unprofitable.* (17) May 17.
Relieving Congestion at the "Diamond" in Youngstown.* (17) May 17.
Bournemouth Corporation Tramways.* I. Bulfin. (114) May 24.
Cement and Concrete Testing for Subway and Elevated Lines in New York City. (86) May 28.
Street-Car Loop Subway Proposed by Pittsburgh.* (13) May 29.
Car Body Maintenance in Belfast.* P. Williamson. (17) May 31.
The Zone Fare in Practice—Dublin.* Walter Jackson. (17) Serial beginning May 31.
Relieving Congestion in Baltimore's Delivery District.* L. H. Palmer. (17) June 7.
Cutting Most of the Compromise Out of the Compromise Joint.* (17) June 7.
Overhead and Time Cost to Erect Elevated Railway. A. P. Roscoe. (13) June 12.
Manganese Special Work Repaired by Welding.* Julian M. Scott. (17) June 21.
Continuous Trains for Forty-Second Street Transit.* Henry B. Seaman. (13) June 26.
Sewer Work Puts Extra Tax on Way Department in Brooklyn. (17) June 28.
Riser Increase Life of Frogs and Mates.* C. L. Hawkins. (17) June 28.
Selbsttätige Wagenkupplung für Strassenbahnen.* (107) Apr. 26.

Roads and Pavements.

Design of Concrete Sidewalks and Concrete Curb and Gutter at Street Intersections.* W. Robert Paige. (60) May.
Poor Brick Causes Pavement Failure—The Saving of $50 for Tests Leads to Failure of a $50 000 Job.* C. C. Wiley. (60) May.
Design and Construction of the Dixie Highway from Rockwood to Monroe, Mich. Leroy C. Smith. (60) May.
Design and Construction of the Monolithic Brick Road South of Seneca, Ill.* A. H. Hunter. (60) May.
Procedure in Constructing an Open Joint Wood Block Pavement at Toledo, Ohio.* Raymond Pierce. (60) May.
Some Specific Suggestions on the Drainage of Roads. (60) May.
Cost of Highway Concrete Delivered Wet by Trucks.* (13) May 1.
Defects in Surface of Bituminous Pavement Due to Concrete Base.* H. W. Skidmore. (13) May 1.
Charging Concrete Mixers on Road Work. Wm. Ord. (16) May 1.
The Cost of a Mile of Road. George A. Duren. (From paper read before an Engineering and Road Builders' Congress at Mineral Wells.) (86) May 7.
Effect of Tractive Resistance in Terms of Gasoline Consumption. (86) May 7.
General Features of Brick Pavement Construction. A. T. Goldbeck and F. H. Jackson. (From *Public Roads.*) (86) May 7.
Special Types of Brick Pavement Construction. (From *Public Roads.*) (86) May 7.
Machine Finishing Concrete Roads.* E. G. Carr. (86) May 7; (67) June.
Sidewalk Construction for New Boulevard Link, Chicago.* (86) May 7.
Illinois Adopts a Uniform Basis of Design for All Types of Rigid Pavement. Clifford Older. (13) May 8.
Bituminous Macadam. A. W. Dean. (Paper read before Canadian Good Roads Congress.) (96) May 22; (86) June 4.
Hot Mix Asphalt Pavements. Francis P. Smith. (Abstract of paper read before Canadian Good Roads Congress.) (96) May 22; (13) June 5.
Road Machinery. Arthur H. Blanchard. (Paper read before Canadian Good Roads Congress.) (96) May 29; (86) June 4; (13) June 5.
Highway Maintenance. J. A. Duchastel. (Paper read before Canadian Good Roads Congress.) (96) May 29.

* Illustrated.

Roads and Pavements—(Continued).

Gravel Roads.* Chas. Talbot. (Paper read before Canadian Good Roads Congress.) (96) May 29.
Concrete in Roads, Bridges and Culverts.* H. Eltinge Breed. (Paper read before Canadian Good Roads Congress.) (96) May 29; (60) June; (13) June 5.
Handling Materials on a Michigan Road Job. (67) June.
The Design and Construction of Modern Granite Block Pavements with Special Reference to Practice in Borough of Manhattan.* C. M. Pinckney. (60) June.
Highway Requirements for Twentieth Century Transportation, with Special Reference to New Jersey Practice. Wm. G. Thompson. (Abstract of paper read before National Highway Traffic Assoc.) (60) June; (86) June 4.
How Albany, N. Y. Saved Over $360 000 in Using Re-Dressed Granite Paving Blocks.* (60) June.
Location of Subsurface Pipe Lines to Conserve Street Pavement. Harry M. Adams. (60) June.
Road Surfacing with Sand Clay from Salt-Flats. R. H. Phillips. (From *Public Roads.*) (86) June 4.
Use of Calcium Chloride as Dust-Preventive on Gravel Roads. W. Leroy Ulrich. (From *Public Roads.*) (86) June 4.
Methods of Constructing Roads Through Sandhill Regions. Paul E. Brown (Abstract of paper read before Nebraska Road Inst.) (86) June 4.
Winter Roads. A. Lalonde. (Paper read before Canadian Good Roads Congress.) (96) June 5.
Multiple-Strip Concrete Road to Conserve Material.* (13) June 12.
How to Obtain Best Results in Constructing 1-Course Bituminous Macadam. F. C. Pillsbury. (From *Public Roads.*) (86) July 2.
Suggestions for the Construction of Concrete Roads.* Clyde E. Learned. (From *Public Roads.*) (86) July 2.
Method of Staking Out Concrete Fords or Dips.* George A. Duren. (From *Concrete Highway Magazine.*) (86) July 2.
Instruction for Field Inspection of Road Materials. (Issued by New Jersey State Highway Dept.) (86) July 2.
Water and the Subgrade. J. L. Harrison. (From *Public Roads.*) (86) July 2.
Paving Blocks and Sectional Paving for Railway Tracks.* (17) July 5.
Character and Cost of Highways for Motor Truck Use.* S. Whinery. (13) July 10.
Road-Construction Problem in West Virginia Mountains.* M. A. Rogers. (13) July 10.
Comparison of Road Subgrade and Air Temperatures.* C. C. Wiley. (13) July 17.
Tests of Thin-Base Monolithic-Brick Road.* Harlan H. Edwards. (13) July 17.
Die natürliche Beleuchtung der Strasse.* A. Burchard. (40) Jan. 18.

Sanitation.

A Few Notes on Sewage Works of the Aircraft Manufacturing Company at Kingsbury. R. C. N. Newport. (114) May.
The Operation and Maintenance of Utilities at Army Camps and Cantonments.* George A. Johnson. (109) May.
Land Drainage Procedure in Iowa.* G. D. Hart. (60) May.
Sewage Disposal of the Loop District, Chicago.* C. D. Hill. (117) May 15.
Disposal of Sewage by Treatment with Acid. Edgar S. Dorr and Robert Spurr Weston. (96) May 15.
Operation of Fine Sewage Screens at Long Beach, California. (13) May 22.
Irrigation Schemes in Egypt and the Sudan.* (12) Serial beginning May 23.
Some Broader Aspects of Rain Intensities in Relation to Storm Sewer Design.* Robert E. Horton. (60) Serial beginning June.
Some Unusual Sewerage Problems and How They Were Solved at Ocean Beach, New York.* Andrew J. Provost, Jr. (60) June.
Sanitation without Sewers. (117) June 1.
Chicago's Relief Sewers.* C. D. Hill. (117) June 1.
The Numerical Interpretation of Bacteriological Tests.* Milton F. Stein. (13) June 5.
Moore Park Drainage System, Toronto.* (96) June 5.
Trade-Waste Treatment Studies in Wisconsin. E. J. Tully. (13) June 12.
Chicago's Standard of Sewer Construction. C. D. Hill. (117) June 15.
Test of Air Diffusers for Activated Sludge Process.* F. L. Mickle. (From *Bulletin* issued by Division of State Water Supply of Illinois.) (86) July 9.
Sewer-Construction Records Used at Scarsdale, New York.* Perry Thompson. (13) July 17.
Die Melioration der Linksufrigen Linthebene in den Kantonen Schwyz and St. Gallen.* (107) Mar. 1.

* Illustrated.

Structural.

The Protection of Iron with Paint Against Atmospheric Corrosion.* J. Newton Friend. (71*a*) Vol. 9, 1918.
Handling and Storing Bulk Cement.* Wallace R. Harris. (4) Jan.
The World's Biggest Building Project.* Arthur J. Widmer. (115) Mar.
The Lighting of Buildings. (*Bulletin* issued by Illuminating Eng. Soc.) (6) Serial beginning May; (86) May 28.
Why Materials of Construction Should be Treated Prior to Their Use. Emmanuel Mavant. (60) May.
An Aircraft Shed.* Frank Baines. (114) May.
Practical Rules for the Seasoning of Wood.* Harold S. Betts. (Abstract from *Bulletin* issued by U. S. Dept. of Agriculture.) (87) May.
Physical Properties of Mortars and Concretes.* H. M. Thompson. (96) May 1.
Reinforced Concrete Building for Canadian National Railways Coach Cleaning and Storage Yard, Halifax Ocean Terminals, Halifax, N. S.* J. J. Macdonald. (96) May 1.
Concrete-Frame Factory Building Has Wooden Roof. W. E. Turner. (13) May 8.
Erecting Long-Span Roof Over Steel Mill by Rolling Trusses to Place.* (13) May 8.
Bulking Effect of Moisture in Sands.* Llewellyn N. Edwards. (96) May 15.
Construction of Army Supply Base at Norfolk.* (117) May 15.
Improving Concrete by Rodding. F. E. Giesecke. (13) May 15; (86) May 21.
Strength of Various Long Columns.* William Jackson. (96) May 22.
Reinforcing Steel Stacks with Gunite Concrete.* M. C. Sherman. (64) May 27.
Practical Considerations in Design of Steel Mill Buildings. R. Fleming. (Abstract of paper read before Buffalo Eng. Soc.) (86) May 28.
Cement and Concrete Testing for Subway and Elevated Lines in New York City. (86) May 28.
Faulty Foundation Causes Serious Damage to Armory.* (13) May 29.
Brick Chimney Carried on Platform at Roof of Building.* J. G. Mingle. (13) May 29.
How One Contractor Went About a Housing Job.* Joseph Meltzer. (13) May 29.
Natural Draught Cooling Towers.* Harold Nielsen. (12) May 30.
Planning the Industrial Plant.* Hugh M. Wharton. (9) Serial beginning June.
Weighing Concrete Materials Saved Cement on Three Big Dams.* H. H. Hunt. (67) June.
The Complete Concrete House.* (67) June.
Breaking Up Concrete. (67) June.
Cast-Iron Pipe or Welded Pipe for House Drainage Calked-Joint *vs.* Screw-Joint, Wrought-Iron *vs.* Steel Pipe.* William Paul Gerhard. (6) June.
Foundation Subsidence of Portland's Grain Elevator. (Report of Committee read before Comm. of Public Works.) (117) June 1.
Supporting Blast Furnace While Replacing Foundation.* C. W. Lush. (13) June 5.
Builds Houses for Workmen.* (20) June 5.
Production of Albany Molding Sand.* Robert W. Jones. (20) June 5.
Tests of Two Recent Theories for Proportioning Concrete.* G. M. Williams and Watson Davis. (13) June 12.
Pneumatic Caissons Sunk Through Moving Ground.* (13) June 12.
Methods of Preventing the Transmission of Vibrations in Buildings.* A. B. Eason. (26) June 13.
Cement Gun Built Walls and Roof of Army Warehouses.* (13) June 19.
Surface Aggregate or Fineness Modulus for Concrete.* (13) June 19.
Formula and Table of Weights, Steel Roof Trusses.* Marshall L. Murray. (86) June 25.
The Surface Area and Fineness Modulus Methods of Grading Concrete Aggregates.* Duff A. Abrams. (86) June 25; (96) June 26.
Studies in Surface Area Proportioning Method.* R. B. Young. (96) June 26.
Emergency Seasoning of Sitka Spruce.* L. A. Welo. (19) June 28.
Industrial Lighting.* C. E. Clewell. (Paper read before Illuminating Eng. Soc.) (3) July.
The Phenomena of Drying Wood.* Harry D. Tiemann. (3) July.
Lignum-Vitæ, the Vital Wood.* James J. Record. (19) July 5.
Concentrated Load Tests of Yellow-Pine Beams for Shear.* L. R. Manville and C. R. Hill. (13) July 10.
Concrete Building Addition Made at Reasonable Cost.* (13) July 10.
Building the New Orleans Army Supply Base.* (13) July 17.
Pressing Out Mix Water Adds to Cement Mortar Strength.* C. T. Wiskocil. (13) July 17.
Swimming Tank on Third Floor of Concrete Building.* L. R. Viterbo. (13) July 17.
Les Appareils pour l'Injection du Mortier sous Pression.* L. Biette. (33) Feb. 15.
Calcul des Voutes Paraboliques.* L. Robert de la Mahotière. (33) Mar. 8.

* Illustrated.

Structural—(Continued).

Moyens de Protection Employées par les Allemends Contre la Rouille de leur Matériel de Guerre en Acier. (33) Mar. 15.
L'Etude et la Représentation Graphique des Propriétés des Bronzes d'Aluminium.* R. de Fleury. (33) Mar. 29.
Recherches des Sections Economiques des Poutres Simples en Béton Armé Travaillant à la Flexion. G. Guillaumin. (33) Mar. 29.
La Destruction par les Allemands des Voies Ferrés, des Routes et des Voies Navigables, Mesures Prises pour leur Reconstruction.* (33) Apr. 5.
L'Etude des Propriétés des Bronze d'Aluminium. Jean Durand. (33) Apr. 19.
Nouvelle Méthode de Calcul et Propriétés Diverses des Poutres à Travées Solidaires.* P. Sonier. (33) Apr. 19.
L'Emploi de Coffrage en Tole pour le Moulage du Béton et pour la Construction des Maisons.* (33) Apr. 26.
Calcul de l'Effort du Vent dans les Toitures en Arc. F. Grua. (33) May 31.
Flandrische Edelsitze. Hans Vogt. (49) Serial beginning Pt. 1.
Deutsch-Gotisches.* D. Hasak. (49) Serial beginning Pt. 1.
Die Vorkarolingische Basilika St. Emmeram in Regensburg und ihre baulichen Änderungen im ersten Halbjahrtausend ihres Bestandes (740 bis 1200).* Franz Schwäbl. (49) Serial beginning Pt. 1.
Die Einflusslinie für die in einem Punkt rotierende Lasteinheit.* O. Fröhlich. (78) Jan. 1.
Die Wirtschaftlichkeit der Abmessungen beim Plattenbalken.* Max Mayer. (78) Jan. 1.
Die Neubauten des Hauses der Dresdner Kaufmannschaft, der Handelskammer und der Gewerbekammer in Dresden.* (40) Serial beginning Jan. 1.
Holz als Ersatz des Eisens in der Zugbewehrung. (78) Serial beginning Jan. 1.
Riss- und Rostbildungen an Tragwerken aus Eisenbeton.* K. Haberkalt. (53) Serial beginning Jan. 3.
Zur Frage der Knickbeanspruchung beigungssteifer Fachwerkstäbe.* H. Müller-Breslau. (40) Jan. 4.
Dienstanweisung für die Bezirkswohnungsaufsichtsbeamten. (40) Jan. 7.
Einheitformen im Hochbau.* (40) Jan. 11.
Entwurf zu einer Polizeiverordnung, betreffend die Unterbringung von Arbeitern in Massenquarteeren. (40) Jan. 15.
Entwurf zu einer Wohnungsordnung. (40) Jan. 15.
Die evangelische Garnisonkirche mit Kriegergedächtnishalle in Allenstein.* Ludwig Dihm. (40) Serial beginning Jan. 18.
Die Ausstellung "Sparsame Baustoffe" in der Ausstellungshalle am Zoologischen Garten in Berlin. Uber. (40) Jan. 25.
Die neue städtische Volksschule an der Pfarrhofstrasse in München-Giesung.* (40) Serial beginning Feb. 1.
Verschiedene Zement- und Betonkonstruktionen hinsichtlich ihrer Verwendbarkeit Herstellungsweise und einiger Ausbauarten (nach Beispielen).* Kropf. (78) Feb. 5.
Ersatz für Eisenbauten. W. Petry. (78) Feb. 5.
Beton und Eisen auf der Ausstellung "Sparsame Baustoffe" in Berlin.* Heinrichs. (78) Feb. 5.
Stadt- und Landhäuser in Ostpreussen.* Lange. (40) Feb. 15.
Baupolizeiliche Erleichterungen für Mittelhäuser (Dreigeschossige Wohnhäuser). (40) Feb. 26.
Ueber Sparmassnahmen im Eisenbetonbau. (107) Mar. 1.
Wettbewerb für ein Bankgebäude des Schweiz. Bankvereins in Biel. (107) Apr. 5.
Weitere Untersuchungen über Rostschutz. Bruno Zschokke. (107) Serial beginning May 17.
Die Lutherkirche in Freiburg i. B.* Hans Christen. (107) May 17.
Die Einflusslinien des Kontinuierlichen Trägers auf drei Stützen.* Ernst Laube. (107) May 17.

Topographical.

Surveying and Mapping from Airplanes. E. Lester Jones. (Paper read before Pan-Am. Aeronautic Convention.) (19) June 21.
Rules for Drafting Practice.* H. N. Savage. (13) July 17.
Intégraphe Predhumeau-Secrétan.* Predhumeau. (43) Jan.
Geländedarstellung auf Karten.* Walter Blumer. (107) May 17.

Water Supply.

A Study of Water Supply for Budget Purposes.* William W. Brush. (59) Mar.
Further Studies on Gentian Violet as a Means of Eliminating Spurious Presumptive Tests for B. Coli in Water.* Ivan C. Hall and Lillian Jordan Ellefson. (59) Mar.
Economical Construction of a Creek Crossing (Water Main.) John F. Mead. (59) Mar.

---

* Illustrated.

Water Supply—(Continued).

Some Tests of Electrically Operated Deep Well Pumps.* P. S. Biegler and I. W. Fisk. (59) Mar.
Models of Structures in the Catskill Aqueduct System.* (59) Mar.
Thawing Frozen Service Pipes.* A. W. Cuddeback. (59) Mar.
Experience in Thawing Frozen Water Services, Hydrant Branches and Hydrants at Syracuse, New York. Charles A. Windholz. (59) Mar.
Frozen Water Services in the Borough of Queens. John T. Metcalf. (59) Mar.
Meters; Oversizing. William R. Edwards. (59) Mar.
New Meter Rates in the San Francisco District.* Allen Hazen. (59) Mar.
Repairs to Risers in the Shafts of the City Tunnel of the Catskill Aqueduct. J. Waldo Smith. (59) Mar.
Garden Pools.* Charles Dowing Lay. (119) Apr.
Methods of Removing Crenothrix from Public Water Supplies—Chlorine Treatment is Successful. W. F. Monfort. (Paper read before Indiana Sanitary and Water Supply Assoc.) (60) May.
Design of Hydro-Electric Plants for Combatting Ice Troubles.* R. M. Wilson. (5) May.
Opportunities for and Data on Small Municipal Hydro-Electric Plants.* Wm. G. Fargo. (60) May.
The High Service Reservoir of the St. Paul, Minn., Water Works.* W. N. Jones. (60) May.
Rainfall, Absorption and Run-Off on Small Rural Drainage Area.* Ivan E. Houk. (13) May 1.
Stresses and Strains in a Lateral.* E. F. Holinger. (111) May 1.
Electric Filtration Plant.* R. U. Steelquist. (111) May 1.
Circular Concrete Reservoir at Leamington, Ont.* Edward M. Proctor. (96) May 8.
Big Chute Generating Station.* W. L. Amos. (96) May 8.
The Bacteriological Standards for Drinking Water Supplies in Interstate Commerce. Everett Judson. (Abstract of paper read before Indiana Water Supply Assoc.) (86) May 14.
Sweetwater Dam Enlarged for the Third Time.* H. N. Savage. (13) May 15.
Horsepower Requirements of Centrifugal Pumps.* T. M. Heermans. (64) May 20.
Sinking a Concrete Pumping Station in a River.* Keith O. Guthrie. (13) May 22.
Russian Water-Power Possibilities at Dneiper River Rapids.* U. U. Tchikoff. (13) May 29.
Graphical Records of Surge Pressures in Pipe Lines.* Ralph Bennett. (13) May 29.
Features of Mammoth Waterwheel Generator.* (27) May 31.
How Vinton, Iowa, Obtained a Dual System of Water Supply.* J. H. Dunlap. (60) June.
Engines for Small Water Works.* Henry A. Symonds. (28) June.
Break in No. 2 Hydraulic Turbine at Wachusett Power Station, Clinton, Mass.* William E. Foss. (28) June.
Weighing Concrete Materials Saved Cement on Three Big Dams.* H. H. Hunt. (67) June.
Ontario Power Co.'s Plant Extension.* H. A. Gardner. (117) June 1.
Brule River Hydro-Electric Development.* C. U. Seastone. (64) June 3.
Helical Gears Solve Cornwall's Pumping Problem.* R. N. Austin. (96) June 5.
New Water Works System for Amherstburg and Ojibway, Ont. Charles W. Tarr. (96) June 5.
Pumping Station at Aylmer, Ont.* H. L. Shepherd. (96) June 5.
Water-Meter Practice and Testing at Buffalo, New York.* Carl L. Lund. (13) June 5.
Design and Tests of Highly Efficient Air-lift Installation at Fort Bliss, Texas.* J. F. Brown. (13) June 5.
Centrifugal Pumps at the Chicago Water-Works Plants. (13) June 5.
Study of Revenue from Sale of Water to Metered Domestic Consumer.* Philip Burgess. (13) June 5.
Economics of Reinforced Concrete Walls for Uncovered Reservoirs.* H. E. Babbitt. (86) June 11.
Coal Tar Derivative Waste Products Cause of Obnoxious Taste of Milwaukee Water Supply. H. P. Bohmann. (From Report of Waterworks of Milwaukee.) (86) June 11.
Balanced Automatic Sluice Gate for Park Dam. (13) June 12.
Hydro-Electric Development on Nipigon River.* (96) June 12.
Some Hydroelectric Developments of Moderate Size in New England.* (117) June 15.
The 25-Mile Gravity Pipe Line of Everett, Washington.* W. A. Scott. (117) June 15.
Combined Aërator and Mixer for Colloidal Water.* (13) June 19.
Design of Motor-Driven Centrifugal Pumps.* A. T. Clark. (96) June 19.
Enlargement of the Yakima-Tieton Main Canal.* G. C. Finley. (13) June 26.

* Illustrated.

Water Supply—(Continued).

Construction Details on the Marin Water and Power Project.* H. M. Bowers. (111) July 1.
Gamtoos River Irrigation Projects in South Africa. (117) July 1.
Pumping Machinery Used by the Service of Supply of the American Expeditionary Force in France.* (117) July 1.
Spillway Capacities Required for Reservoirs in Western United States.* John T. Whistler. (13). July 3.
Friction Tests and Capacity Table for Cement Pipe.* G. E. P. Smith. (*Bulletin* issued by Univ. of Arizona.) (86) July 9.
The Relation of Depreciation to Investment. W. C. Hawley. (Paper read before Pennsylvania Water Works Assoc.) (96) July 10.
Concrete Pipe Fails from Unequal Expansion of Shell.* G. E. P. Smith. (13) July 17.
Dam Foundation Placed by Suspended Pneumatic Caissons.* (13) July 17.
L'Aménagement Hydraulique du Rhone français. Auguste Pawlowski. (33) Mar. 8.
Recherches sur les Causes de l'Effondrement du Barrage de Calaveras (Californie, E.-U.).* (33) Apr. 12.
Beitrag zur Berechnung der Wände Quadratischer und rechteckiger Behälter mit oberem Rahmen.* R. Bortsch. (78) Jan. 4.
Die Ausnützung der Jogne zwischen Charmey und Broc.* H. E. Gruner. (107) Mar. 8.
Der Ausbau der Wasserkraftanlagen der St. Gallisch-Appenzellischen Kraftwerke. (107) Mar. 29.

Waterways.

Currents at and Near Mouth, Southwest Pass, Mississippi River.* T. E. L. Lipsey. (100) Jan.
Harbor Developments of the Port of Philadelphia in Progress and Contemplated. W. B. Ladue. (2) May.
Progressive Erosion in a Dredged Drainage Channel.* C. E. Ramser. (13) May 1.
Short-Circuiting Floods in the Big Sioux River.* Francis C. Shenehon. (13) May 15.
Ocean Terminals at Halifax.* (117) May 15.
Skeleton Steel Jetties for Bank Protection.* (18) May 17.
Draglines Will Handle 2 000 000 Cu. Yds. of Excavation for Deepening Miami River.* (86) May 21.
Inspection of Drainage Ditch Cross-Sections After Contract Dredging.* E. S. Blaine. (13) May 22.
Sinking a Concrete Pumping Station in a River.* Keith O. Guthrie. (13) May 22.
Wall Construction at Norfolk Army Supply Base by Cement Gun Process.* (86) May 28.
Mechanical Lifts—Past and Present.* (For Canal Locks.) J. F. Robbins. (55) June.
Municipal Freight-Handling Dock and Cranes at St. Paul.* (13) June 5.
Handling Iron Ore at the Head of the Great Lakes.* George H. Herrold. (13) June 5.
Gantry Portal Crane for Yard Work.* (20) June 5.
Mechanical Handling the Feature of Concrete Pile Yard.* (13) June 12.
Valuable By-Products from Gold Dredging. Arthur L. Dahl. (46) June 14.
Army Supply Bases Useful Adjuncts to Railroad.* (15) June 27.
Making Concrete Blocks for Toronto Breakwater.* Frederick Phillips. (96) July 10.
Dam Supported by Bascule Bridge Closes Canal Lock.* (13) July 17.
Recherches sur la Formation des Sinuosités des Cours d'Eau.* Hoc. (33) Serial beginning Mar. 15.
Les Ports Fluviaux de la Ruhr et du Rhin (Prusse rhénane).* J. Tribot-Laspière. (33) Apr. 26.
Les Ports Fluviaux de Strasbourg et de Kehl; Situation des Ports de Strasbourg en 1914 et en 1918.* A. Brillouin. (33) Serial beginning May 3.
Les Voies Navigables d'Alsace et de Lorraine, leur Rôle et leur Avenir (33) May 17.
Les Barrages Automatiques, Barrage Automatique de l'Usine de Tremp (Espagne).* E. Froté. (33) May 31.
Les Ports français et la Guerre.* Auguste Pawlowski. (33) May 31.
Der Ausbau der Weser auf Niedrigwasser.* Muttray and Soldan. (49) Serial beginning Pt. 1.
Weiteres über Abmessungen von Haupt-und Nebenwasserstrassen. Sympher. (40) Jan. 1.
Verbesserte Beleuchtungseinrichtungen am Kaiser-Wilhelm-Kanal.* (41) Jan. 2.
Tragbarer selbstzeichnender Pegel.* A. U. Horn. (40) Feb. 12.
Die Altonaer Fischereihafen-Pläne.* Range. (40) Feb. 22.
Umschlagsverkehr in Häfen, mit besonderer Berücksichtigung schweizerischer Verhältnisse.* U. R. Ruegger. (107) Mar. 15.

* Illustrated.

PAPERS AND DISCUSSIONS

AUGUST, 1919

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INSTITUTED 1852

PAPERS AND DISCUSSIONS

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CONTENTS

Papers: PAGE

Water Supply for the Camps, Cantonments, and Other Projects Built by the Construction Division of the United States Army.
By DABNEY H. MAURY, M. AM. SOC. C. E. ... 399

Address at the Annual Convention in St. Paul and Minneapolis, Minn., June 17th, 1919.
By FAYETTE S. CURTIS, PRESIDENT, AM. SOC. C. E. ... 435

Contracts—A Comparison of "Cost Plus" with Other Forms.
By ERNEST WILDER CLARKE, M. AM. SOC. C. E. ... 443

Physiography of Water-Sheds and Channels, and Analysis of Stream Action of Southern California Rivers, with Reference to the Problems of Flood Control.
By A. L. SONDEREGGER, M. AM. SOC. C. E. ... 451

Comprehensive Plotting of Water Turbine Characteristics.
By KARL R. KENNISON, ASSOC. M. AM. SOC. C. E. ... 475

The Silt Problem of the Zuni Reservoir.
By H. F. ROBINSON, ASSOC. M. AM. SOC. C. E. ... 483

The Accuracy of Water Level Recorders and Indicators of the Float Type.
By J. C. STEVENS, M. AM. SOC. C. E. ... 495

Discussions:

Determination of the Duty of Water by Analytical Experiment.
By W. C. HAMMATT, M. AM. SOC. C. E. ... 505

The Economics of Steel Arch Bridges.
By J. A. L. WADDELL, M. AM. SOC. C. E. ... 515

Improving Arch Action in Arch Dams.
By L. R. JORGENSEN, M. AM. SOC. C. E. ... 529

On a New Principle in the Theory of Structures.
By G. A. MANEY, ESQ. ... 531

The East Canyon Creek Dam.
By MESSRS. SAMUEL FORTIER and A. J. WILEY. ... 543

Pressures in Penstocks Caused by the Gradual Closing of Turbine Gates.
By MESSRS. EUGENE E. HALMOS, R. D. JOHNSON, MINTON M. WARREN, T. NOBLE ANDERSON, FORD KURTZ, and WILLIAM P. CREAGER. ... 553

Sewage and Wastes Disposal for the United States Army.
By MESSRS. LEONARD METCALF, NICHOLAS S. HILL, JR., ALMON L. FALES, KENNETH ALLEN, and G. BERTRAM KERSHAW. ... 573

The Proposed New York and New Jersey Vehicular Tunnel: An Informal Discussion.
By E. E. R. TRATMAN, ASSOC. M. AM. SOC. C. E. ... 587

American Highways: An Informal Discussion.
By H. F. DUNHAM, M. AM. SOC. C. E. ... 591

Memoirs:

OWEN BRAINARD, M. AM. SOC. C. E. ... 595
JOHN STERLING DEANS, M. AM. SOC. C. E. ... 597
RUFUS CAMERON HUNT, M. AM. SOC. C. E. ... 599
JOHN CHRISTIAN OSTRUP, M. AM. SOC. C. E. ... 600
JOHN WARREN SACKETT, M. AM. SOC. C. E. ... 602
NAOJI SHIRAISHI, M. AM. SOC. C. E. ... 605
EDWIN JAMES POTTER, ASSOC. M. AM. SOC. C. E. ... 608
DONALD POWER DENHAM, JUN. AM. SOC. C. E. ... 609

PLATES

Plates V–VII. Illustrations of "Water Supply for the Camps, Cantonments, and Other Projects Built by the Construction Division of the United States Army" ... Pages 405–427

Plate VIII. Map of Westerly Portion of Southern California ... Page 457

Plates IX–XI. Illustrations of "Comprehensive Plotting of Water Turbine Characteristics" ... Pages 477–481

For Index to all Papers, the discussion of which is current in *Proceedings*, see the end of this number.

Vol. XLV. AUGUST, 1919. No. 6.

AMERICAN SOCIETY OF CIVIL ENGINEERS
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PAPERS AND DISCUSSIONS

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WATER SUPPLY FOR THE CAMPS, CANTONMENTS, AND OTHER PROJECTS BUILT BY THE CONSTRUCTION DIVISION OF THE UNITED STATES ARMY

By Dabney H. Maury, M. Am. Soc. C. E.*

Presented April 2d, 1919.

Synopsis.

This paper presents briefly some facts in connection with the organization of the Construction Division, giving credit to those civilians who were principally responsible for the selection of its personnel and for the preparation of the form of contract adopted. It then describes the general standards for the water supply systems of the cantonments and the preparation of the typical preliminary plans, giving an illustration of the manner in which time was saved by the latter.

The preparation of general plans for the distribution system, and the scheduling of materials therefor, are next described and illustrated, and studies of the various water-supply problems are outlined. The paper next sets forth the general specifications and the construction details for water supply, and illustrations of the latter are presented. The scheduling and purchase of service pipe materials and of supple-

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Note.—Discussion on this paper is invited, and may be sent by mail to the Secretary. All discussion will be published in a subsequent number of *Proceedings*, and, when finally closed, the paper, with discussion in full, will be published in *Transactions*.

mentary materials are explained, and the conditions governing the selection of the various materials used are stated.

Under the heading "Sanitation", credit is given to the Sanitary Corps of the Medical Corps for its cordial and efficient co-operation from the very beginning to date, and to the Supervising Engineers, the Engineers for the Contractors, and the Sanitary Officers assigned to the camps, for their excellent work in looking after the quality of the temporary water supplies during the construction period.

Additional sanitary precautions insisted on by the office of the Advisory Engineer for Water Supply are stated. The methods by which water-works materials for the National Guard camps were shipped to these camps in advance of plans, and in most cases in advance of the arrival of engineers, contractors, or working forces, is narrated.

The enlargement of the scope of work of the Construction Division is mentioned, and a number of working plans for water-works are presented and described.

The paper states the consumption of water in the camps and the methods adopted to check leakage and waste, and also the changes in the National Guard camps and the manner in which water-supply materials were made available for these changes before such changes had been authorized.

The preparation of contracts for water supply extensions and for water service, and the rates at which water was furnished to the Government, are next treated.

Finally, the paper represents a summary of the work done and of the results accomplished in First Cost, Sanitation, and Fire Protection, and gives credit to all those who bore a responsible part in the work, whether in the office or in the field.

Organization.

Much has been written about the remarkable achievements of the Construction Division of the Army, and no man who served in that Division, in no matter how humble a capacity, can fail to be proud of having been connected with an organization so notably efficient.

It would be unfair to praise the Construction Division, however, without first giving credit to the men who were not thereafter officially

connected with it, but who in the very beginning helped to select the major part of its official personnel and to mobilize its contractors, and who collaborated with the Office of Cantonment Construction in the preparation of a form of contract absolutely different from any that had ever been used on Government work, but which has been proved to be the only form which could have produced the desired results.

The list of the men, to whose energy, ability, practical patriotism, and wise counsel the country owes so much, included, among others, Messrs. Morton C. Tuttle, Leonard Metcalf, George W. Fuller, William O. Washburne, Frederick Law Olmstead, Asa E. Phillips, and Col. William A. Starrett.

In those crucial early days in April, May, and June, 1917, after it had finally been decided that the United States should prepare to do its part in the greatest war of history; when practically no army was available and there was no place to train one; and when every additional day's delay in getting troops to France meant the loss of many more lives and vast treasure, these men spent weeks in Washington doing work of incalculable value to the country, and without other recompense than the joy of serving.

When the writer was "telegraphed" into service on May 28th, 1917, the work of these men had begun to show results. The Office of Cantonment Construction, starting with a personnel of 10, already numbered 40 or 50, and the men who were lucky enough to be selected were racing in from all parts of the country to take up their duties. In October, 1917, the number had increased to 700; in March, 1918, to 1 400; and when the Armistice was declared, on November 11th, 1918, the force in the Washington office alone numbered 2 800, and about 25 000 more, scattered all over the United States and its insular possessions, were reporting to Gen. Marshall, Chief of Construction Division, which number did not include any of the 200 000 laborers or other employees of the contractors.

The day before the writer's arrival in Washington, Clarence Goldsmith, M. Am. Soc. C. E., Hydraulic Engineer of the National Board of Fire Underwriters, had reported to the Officer in Charge of Cantonment Construction. The services of Mr. Goldsmith had been generously donated to the Government by the National Board of Fire Underwriters up to April 6th, 1918, when he was commissioned a Major in the Quartermaster Corps. From May 28th to date he has been Prin-

cipal Assistant to the Advisory Engineer for Water Supply. His loyalty, untiring energy, and exceptional ability, as a designer of water-works and fire protection systems, have saved millions for the Government.

During the period of construction of the Cantonments and National Guard Camps, no further increase was made in the personnel of the Office of the Advisory Engineer for Water Supply, the services of such assistant engineers, computers, draftsmen, or stenographers as were required being supplied from the general offices of the Construction Division. In the latter part of 1917, the number and diversity of the problems submitted to the office necessitated the organization of an additional and independent force. The members of this force were, without exception, active, industrious, and faithful, and to every one of them the writer desires to give credit for work well done, and to express his grateful appreciation of their loyal co-operation.

General Standards.

In all water-works designed by this office, the first consideration has always been the sanitary quality of the supply, of which more will be said later. This being assured, the first point to be determined in the actual design of the water-works system was the quantity of water required. This was basic, and entered into every part of the design.

It was necessary to provide a supply sufficient, in the practical operation of the cantonment, for every reasonable requirement of the troops, for domestic use, as well as for proper fire protection. The restrictions and limitations included the following: the limited appropriations; the enormous prices of material and labor; the difficulty of obtaining on short notice as much of either as would be required for the simultaneous construction of sixteen camps to house about 40 000 troops each; the necessity of avoiding, in so far as possible, the use of steel or iron, both of which were urgently needed for ships, guns, and munitions; and, above all, the absolute necessity for haste.

It was early recognized that some leakage and waste would be unavoidable; at the same time it was believed that the concentration of most of the water fixtures in lavatories, where from forty to seventy outlets could be inspected almost at a glance, and the fact that, under military discipline, proper administrative rules could be enforced,

would combine to make it an easy matter to reduce leakage and waste to relatively small quantities.

More consideration was given to the determination of the proper allowance of water than to any other question, and Leonard Metcalf, and George W. Fuller, Members, Am. Soc. C. E., collaborated with this office in the consideration of this important and fundamental subject.

After the quantity of water required for domestic consumption had been determined, the question of fire protection was studied, and the requisite quantity and the pressure at which this quantity should be available were determined.

Typical Preliminary Plans.

The broad and general engineering standards which should govern the construction of the water systems to supply the camps having been determined, the next most important problem was the preparation of such plans for the individual systems as would require the minimum time for construction, utilizing such material as would not hamper the progress of shipbuilding and other vital war industries, and would at the same time furnish safe, adequate, and reliable service.

Typical plans of the building layouts of the several units of a standard divisional cantonment were prepared by the Camp Planning Section and transmitted to this office, as were also typical plans showing various methods in which these several units could be grouped on the ground. It was manifest at the outset that no particular arrangement of units could be adhered to for all the camps, as the grouping would necessarily have to be governed in each case by the topography of the camp site. It was possible, however, in almost every case, to adhere strictly to the group plan of buildings in each of the several units, and this permitted the preparation of standard plans showing the location of mains, and the location and sizes of the service pipes in each unit.

Fig. 1 is a typical plan of the mains and service pipes in a Regimental Unit. The lengths and sizes of the mains, and their location outside the limits of the individual units, were governed in each case by the topography, which dictated the way in which the units were strung together, and also by the point at which the water supply was delivered to the camp.

Plate V shows several typical arrangements of water distribution mains, corresponding to various groupings of the units in a Divisional Cantonment. In one case the units are strung out in a single line, with the supply coming in at one end; in another, with the units strung out as before, the supply comes in at the center; and, in the third case, the units are grouped in horse-shoe form. This latter arrangement was the ideal one, as it gave an opportunity to loop the mains across the ends of the horse-shoe, which greatly reduced the friction losses and enabled smaller mains to be used.

In the preparation of these typical plans, studies were made to determine in each case the economic location and sizes of the mains, gates, and fire hydrants, so that, by the time the first rough plan showing the approximate actual grouping of the units on the ground in any particular camp was submitted to this office, it might be possible, with the minimum of delay, to specify off-hand the sizes and the approximate lengths of mains required and to place orders for the bulk of the water-works materials.

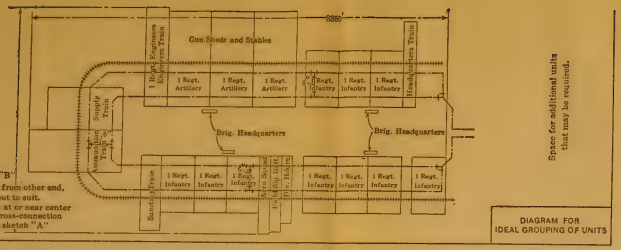
As an instance of the way in which time was saved by this method, the case of Camp Lewis may be cited. It had been decided to build a cantonment near American Lake, Washington, but two local factions had been unable to agree on the proper location, and Maj., afterward Col., Peter Junkersfeld, of the Building Division of the Construction Division, was sent out to settle the matter and fix the final location of the camp. On the day after his arrival, he sent a telegram which read as follows:

"Refer Government Maneuver Map No. 69. Follow railroad southwesterly from American Lake to Dupont Station. Draw line easterly from this station to point midway between Spray Lake and Spray Farm. This line is the center axis of camp, which is in typical horseshoe plan with open end eastward. Source of water supply, wells and springs between American Lake and Sequalitchew Lake. Site for reservoir, Hill No. 320; actual elevation, 390. Engineering Division wire sizes and lengths of water mains required."

This telegram arrived at the Washington office just before midnight, and within two hours the Engineering Division wired the information required, which information enabled the pipe for the distribution mains of the camp to be ordered immediately from the nearest Pacific Coast fir pipe manufacturers. A few hours thus sufficed to settle a basic question in connection with a cantonment more

PLATE V.
PAPERS, AM. SOC. C. E.
AUGUST, 1919.
MAURY ON
WATER SUPPLIES FOR
CANTONMENTS, CAMPS, ETC.

CANTONMENT GROUNDS
TYPICAL WATER AND SEWERAGE PLAN
GENERAL PLAN

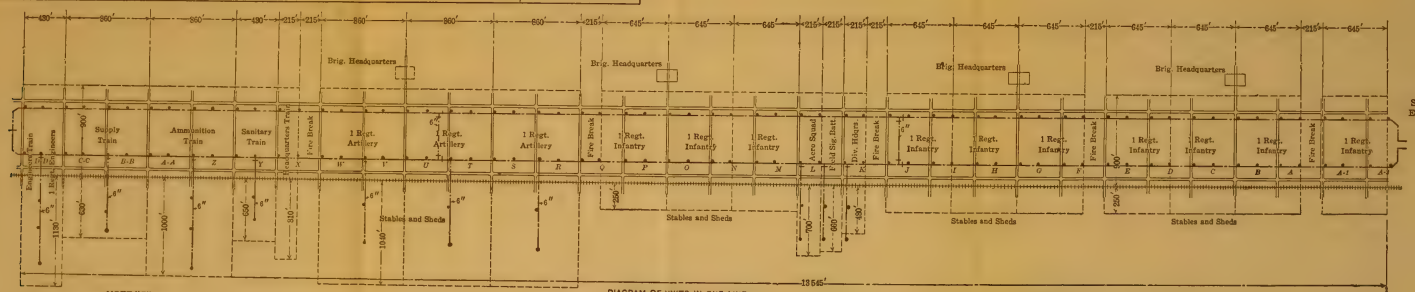


NOTE "B"
If supply comes from other end, reverse this layout to suit.
If supply enters at or near center of one side use cross-connection layout shown in sketch "A"

NOTE "A"
For center feed use layout and pipe sizes as per sketch "A". All 6" pipe lines to be the same for center feed as for end feed, except that the central 6" cross-connection shown on end feed plan is replaced in the center feed plan by the two 12" cross-connections shown on sketch "A".

SKETCH "A"

GENERAL NOTE
The number and arrangement of units will, of course, vary for each cantonment, and it is likely that in no case will they correspond closely to this plan. It is important, however, that the location of water mains and hydrants, with regard to each unit in each cantonment, should follow closely the layout shown hereon. No matter how much it may be necessary to alter the positions of the respective units, or to curve the mains between them, the mains should run straight across each unit, and in the positions shown on this plan.

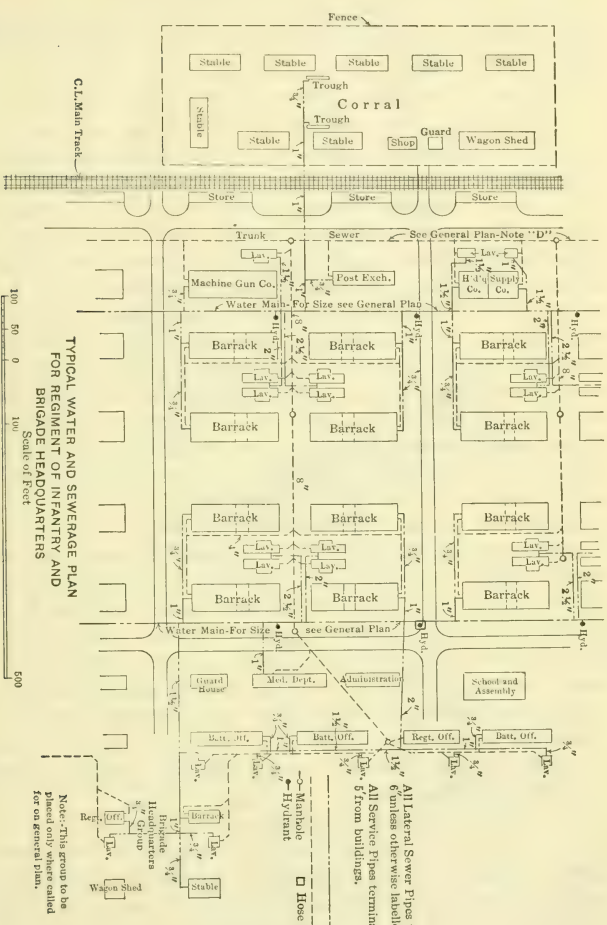


NOTE "C"
WATER PIPES
For layout of water pipes for each unit, see typical water and sewerage plans for each unit.
For construction details of water pipes, see construction detail sheets.

LEGEND
Water Pipe
Hydrants
Gates

Scales
1000 500 0 1000 2000 3000
1/4 Mile 1/4 Mile

NOTE "D"
SEWERS
For layout of sewers for each unit, see typical water and sewerage plans for each unit.
Trunk sewers are to be planned by engineer in charge of each cantonment to suit the topography and other conditions of that particular site.



TYPICAL WATER AND SEWERAGE PLAN FOR REGIMENT OF INFANTRY AND BRIGADE HEADQUARTERS

FIG. 1.

than 3 000 miles away. Although the location of this camp was not definitely decided until after June 28th, the camp was ready for troops on September 1st.

PLANS OF DISTRIBUTION SYSTEM AND SCHEDULES OF MATERIALS.

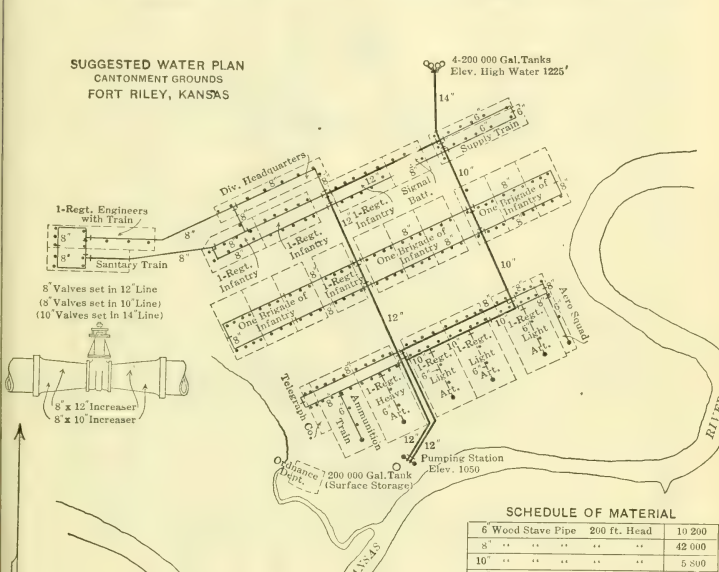
The City Planners and Engineers on the ground at each camp sent in as fast as possible topographic maps of each camp site, on which were shown the general arrangement of the several units; and as soon as this general arrangement was approved by the Camp Planning Section, a blue print was furnished to this office. The locations and sizes of the water mains, fire hydrants, valves, and other accessories were immediately drawn on these blue prints with red pencil; from these red pencil marks the necessary materials were scheduled, and the schedule was sent to the Materials Division for purchase. The blue print with the red marks on it was then sent back to the Drafting Room of the Camp Planning Section, where it was traced as a water-works drawing, and given its proper number. Blue prints from these tracings were forwarded to the camps, but the method of handling the work in this office actually enabled most of the water supply materials to be shipped to the camp before the plans arrived.

Fig. 2 shows the water distribution system for Camp Funston. The supply was from wells, low-lift pumps at which delivered water into surface storage at the pumping station, whence it was pumped through the distribution mains and into elevated storage on the hills on the other side of the camp. This arrangement gave an ideal system, as the elevated reservoirs furnished a second source of supply, and their location on the opposite side of the camp greatly reduced the friction losses in the mains. It will also be noted that there are duplicate supply mains from the pumping station as well as from the reservoirs; that the distribution mains are looped everywhere; and that there are no dead ends.

Fig. 3 shows the water-works layout for Camp Grant, which embodies many of the same features as that for Camp Funston, the principal difference being that at Camp Funston the near-by hills enabled wood-stave tanks to be used for storage, and at Camp Grant the flat topography compelled the use of the more expensive steel tank on a steel tower.

Fig. 4 shows the arrangement of mains and service pipes for a typical base hospital unit. The presence of the corridors connecting

all the buildings made it difficult to furnish effective fire protection to the hospitals; first, because they eliminated fire-breaks and offered a fine chance for a fire to spread from one building to another; and, second, because they blocked access for the fire fighters to the interior



SCHEDULE OF MATERIAL

6" Wood Stave Pipe 200 ft. Head	10 200
8" " " " " "	42 000
10" " " " " "	5 800
12" " " " " "	10 400
14" " " " " "	1 300
6" Gate Valves	9
8" " "	53
10" " "	1
A.W.W.A. Standard Specials	
50 Tons C.I. Special Castings	
60 Tons C.I. Pipe	
Hydrants (3½" Cover)	210
Valves at Pumping Station not included	

FIG. 2.

courts between the corridors and the buildings. To offset these disadvantages, as much as possible, all hospital groups were given duplicate supply mains, the distribution mains were very thoroughly looped and gated, the hydrant spacing was made unusually close, and, wherever possible, openings were left under the corridors at strategic points.

Studies of Water-Supply Problems.

The foregoing describes more particularly the method of procedure in regard to the distribution system, which naturally formed the larger part of the water-works construction. The selection of the source of

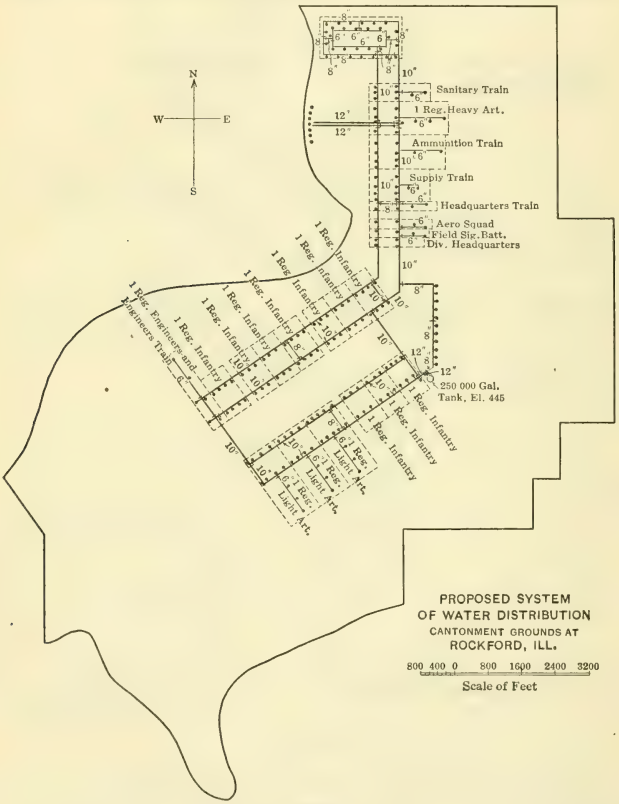


Fig. 3.

supply, the determination of the method of bringing it to the camp, and the planning of pumping stations, purification works, or reservoirs, if any or all of these were required, were usually governed largely by

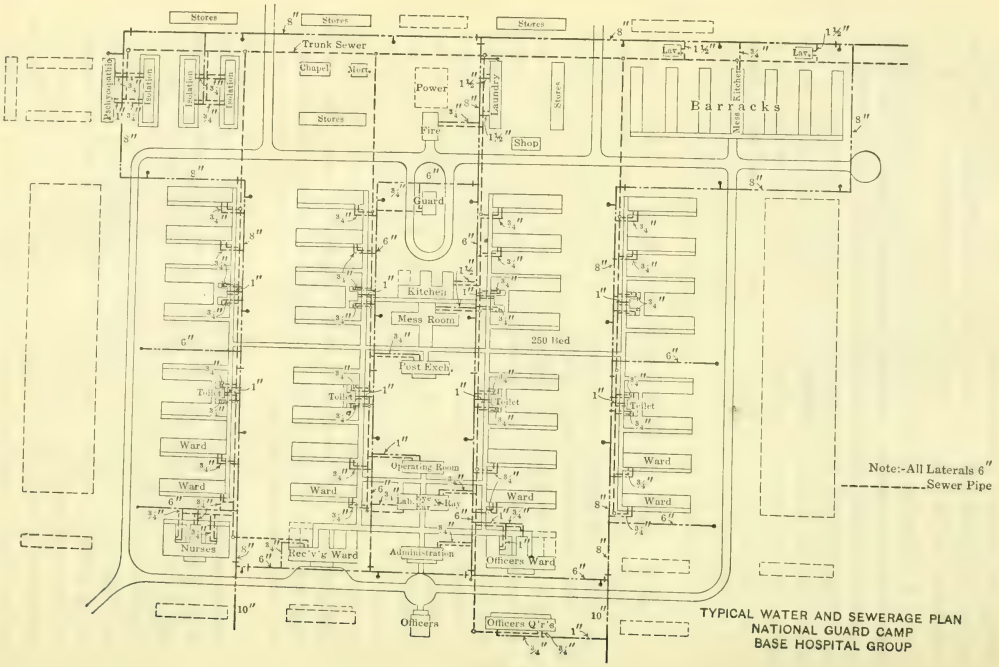

Stores
Trunk Sewer
Chapel
Mort.
Power
Laundry
Fire
Shop
Barracks
Mess
Kitchen
Guard
Kitchen
Mess Room
250 Bed
Post Exch.
Toilet
Ward
Operating Room
Lab. & X-Ray
Nurses
Rec'v'g Ward
Administration
Officers Ward
Officers
Officers Q'r's
Isolation
Pathological
Note:-All Laterals 6"
Sewer Pipe
TYPICAL WATER AND SEWERAGE PLAN
NATIONAL GUARD CAMP
BASE HOSPITAL GROUP

FIG. 4.

information conveyed in the reports of the supervising engineers from the camps themselves. Each of these problems was dealt with as fast as the necessary information became available. In some instances, the information was already at hand, either as a result of previous knowledge of the local water supply conditions on the part of the engineers in this office, or in the form of previous reports. Quite often the excellent reports, issued by the National Board of Fire Underwriters, on cities from which the camp supply might be taken, made immediately available most of the information required in regard to such city supplies.

In the beginning, of course, it was impossible, with no data and no time available, to send detailed plans from Washington, and the efforts of the office were necessarily confined to impressing on the supervising engineers at the camps the necessity of adhering to the general standards established by the office, leaving the details to be worked out in the field. These men included many of the very best engineers in the United States; but it was quite natural that any engineer not familiar wth the reasons which had controlled the establishment of these standards, should approach the problem much as he would the design of a metropolitan water system, and plan for capacities sufficient to take care of normal growths in population over a period of 20 or 25 years. As opportunity offered, conferences were held with these supervising engineers, at which the reasons for the adoption of the various standards were explained, and these conferences almost invariably cleared up the situation and produced excellent results.

General Specifications and Construction Details.

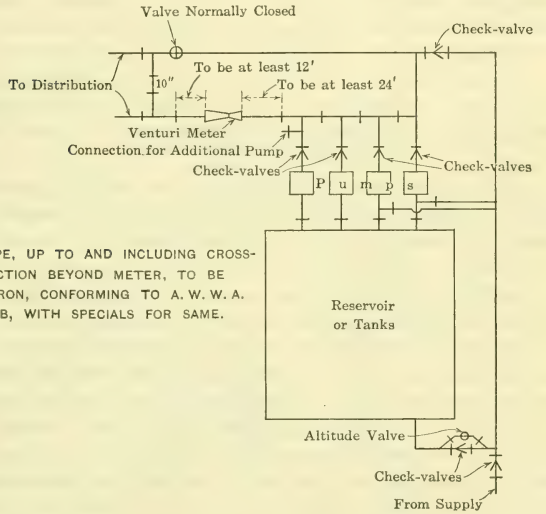
In the meantime, general specifications for water supply to the cantonments, and typical construction details showing the method of setting valves, valve boxes, and hydrants, of connecting wood-stave pipe to cast-iron pipe or specials, of making connections between mains, of making bends in mains, of connecting service pipes to mains, the arrangements of pipe connections to pumping stations and reservoirs, etc., were prepared and sent out, as well as a schedule of service pipe materials necessary for each individual unit in a cantonment.

Fig. 5 is a diagrammatic layout used in planning the piping connections at pumping stations and reservoirs. The duplication of suction and discharge mains, and the location of gate-valves and check-

TYPICAL ARRANGEMENT FOR PUMPING STATION

CONSTRUCTION DETAILS
FOR

TYPICAL LAYOUT OF PUMPS, RESERVOIR, TANKS, METER AND PIPE CONNECTIONS, FOR WATER SYSTEMS IN WHICH SUPPLY IS DELIVERED INTO STORAGE AND HAS TO BE PUMPED THENCE INTO THE DISTRIBUTION MAINS, AND WHERE THERE IS NO ELEVATED STORAGE ON DISTRIBUTION MAINS. WHERE THERE IS SUCH ELEVATED STORAGE, THE NUMBER OF PUMPING UNITS MAY BE REDUCED.



WHERE PUMPS DO NOT TAKE SUCTION UNDER HEAD, PROVIDE SUITABLE PRIMING APPLIANCES IN DUPLICATE.

WHERE EXCESSIVE PRESSURES MIGHT OTHERWISE COME ON MAINS, AS THE RESULT OF SHUTTING OFF DRAFT WHILE PUMPS ARE RUNNING AT HIGH RATES, SUITABLE RELIEF VALVES SHOULD BE PROVIDED AT PUMPING STATION.

FIG. 5.

valves, make it impossible for the failure of any one valve to put more than two pumping units out of commission, or for the failure of any pipe or special casting to put more than one unit out of commission. Attention is called to the by-pass around the Venturi meter and to the arrangement of the altitude valve on the line supplying the reservoir.

In Fig. 6 are three construction details, the one in the upper left corner showing a bend in a wood-stave pipe line, with two 45° ⌞ s and a length of cast-iron pipe on each side to prevent blow-off. The lower left detail shows a typical connection between existing and new wood-stave mains, by which the use of a cross is avoided. Crosses are more often defective than tees, and the failure of a cross puts all four connecting lines out of service.

The detail on the right illustrates the method of connecting altitude valves. The full size of the outlet check gives free outflow, and the reduced size of altitude valve saves money. The bends facilitate repairs.

In Fig. 7 the upper left detail shows the method of connecting a hydrant to a wood-stave main, and the short 4-in. hydrant branch used. The lower left detail shows the connection of branch lines to wood-stave mains; the upper right shows the connection of a hydrant to the end of a 6-in. wood-stave main; and the lower right shows the method of protecting valves and valve boxes from injury by traffic.

Fig. 8 shows the lead joint used for connecting wood-stave pipe to cast-iron pipe, valves, or fittings, and describes the method of making the joint. When the first orders were placed for wood-stave pipe the office was definitely informed that it was common practice to lead the tenons of the wood pipe into standard cast-iron hubs in the same way that cast-iron spigots are leaded in; but reports soon began to come in from the camps to the effect that this was by no means an easy thing to do. A great many methods were suggested for making these joints, but by far the best of all was that shown on Fig. 8, the idea for which was suggested at about the same time by Mr. Ramsey, Water-Works Engineer for Morris Knowles, Incorporated, Supervising Engineers for Camp Meade, and by an engineer for a camp in the Middle West. The success of the method depended largely on having all the tenons made small enough to provide proper lead space, and on having the diameter of the tenons accurately

DETAILS.
90° CURVE WITH WOOD STAVE PIPE,
EXISTING AND NEW WOOD STAVE MAINS,
STANDARD SETTING FOR ALTITUDE VALVE.

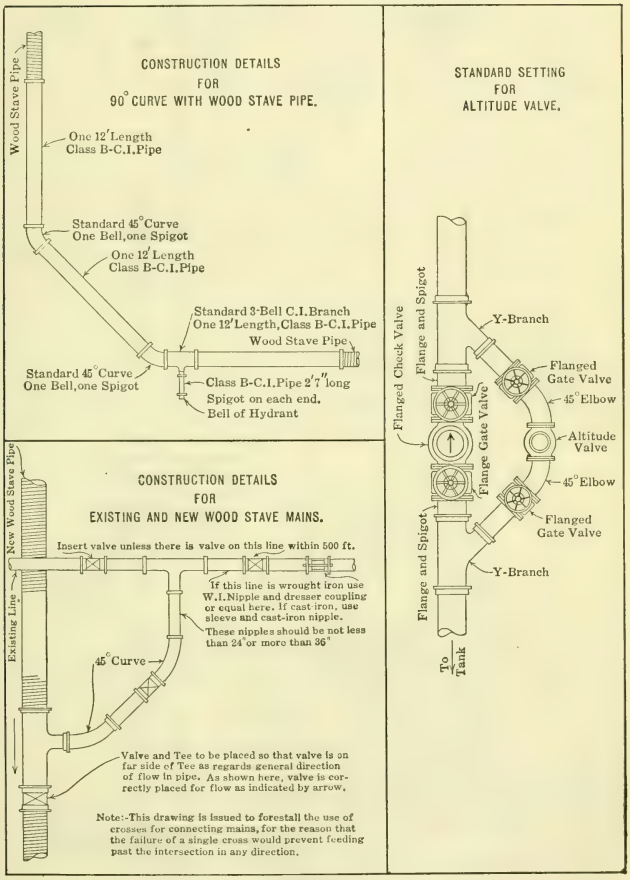
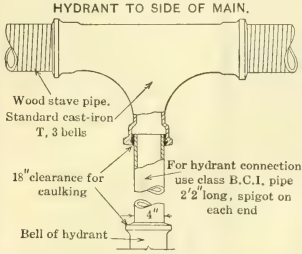

CONSTRUCTION DETAILS
FOR
90° CURVE WITH WOOD STAVE PIPE.
Wood Stave Pipe
One 12' Length
Class B-C.I.Pipe
Standard 45° Curve
One Bell, one Spigot
One 12' Length
Class B-C.I.Pipe
Standard 3-Bell C.I.Branch
One 12' Length, Class B-C.I.Pipe
Wood Stave Pipe
Standard 45° Curve
One Bell, one Spigot
Class B-C.I.Pipe 2'7" long
Spigot on each end.
Bell of Hydrant
CONSTRUCTION DETAILS
FOR
EXISTING AND NEW WOOD STAVE MAINS.
New Wood Stave Pipe
Existing Line
Insert valve unless there is valve on this line within 500 ft.
If this line is wrought iron use W.I.Nipple and dresser coupling or equal here. If cast-iron, use sleeve and cast-iron nipple.
These nipples should be not less than 24" or more than 36"
45° Curve
Valve and Tee to be placed so that valve is on far side of Tee as regards general direction of flow in pipe. As shown here, valve is correctly placed for flow as indicated by arrow.
Note:-This drawing is issued to forestall the use of crosses for connecting mains, for the reason that the failure of a single cross would prevent feeding past the intersection in any direction.
STANDARD SETTING
FOR
ALTITUDE VALVE.
Flanged Check Valve
Flange and Spigot
Flange Gate Valve
Flange and Spigot
To Tank
Y-Branch
Flanged Gate Valve
45° Elbow
Altitude Valve
45° Elbow
Flanged Gate Valve
Y-Branch

FIG. 6.

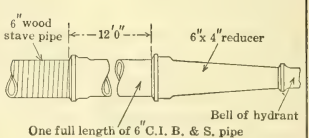
DETAILS
WOOD STAVE PIPE,
BRANCH LINE, VALVES, AND VALVE BOXES.

DETAILS FOR CONNECTING FIRE HYDRANT TO SIDE OF MAIN.

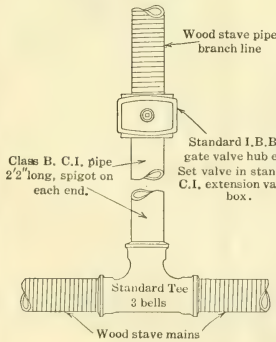

Wood stave pipe.
Standard cast-iron T, 3 bells
18" clearance for caulking
For hydrant connection use class B.C.I. pipe 2'2" long, spigot on each end
4"
Bell of hydrant

Hydrant to be of reputable make, to have valve opening at least 4" diam., and to discharge 500 gal. per min., with friction loss of not more than 3 lb. Length of barrel to suit depth of cover required at cantonment. If branch is longer than 2'2" use 6" pipe.

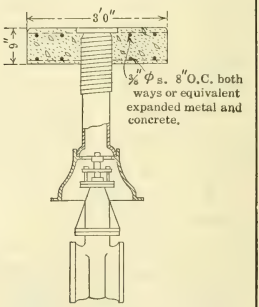
DETAILS FOR CONNECTING FIRE HYDRANT TO END OF MAIN.



DETAILS FOR CONNECTING BRANCH LINES TO MAIN.


Wood stave pipe branch line
Standard I.B.B.M. gate valve hub ends. Set valve in standard C.I. extension valve box.
Class B. C.I. pipe 2'2" long, spigot on each end.
Standard Tee 3 bells
Wood stave mains

DETAILS FOR PROTECTING VALVES AND VALVE BOXES.



In setting valve box, leave at least 4" between valve box and gate at nearest point. Cast around top of each valve box a 1: 2½: 5 concrete disk 3'0" diam. and 9" thick, as shown.

FIG. 7.

LEAD JOINT FOR CONNECTING REDWOOD OR FIR STAVE PIPE TO CAST-IRON PIPE, VALVES, OR FITTINGS.

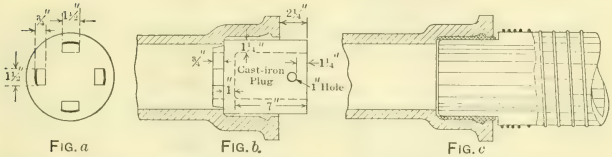


FIG. *a*

BOTTOM VIEW OF PLUG SHOWING RECESSES IN ¾" EXTENSION TO ACCOMMODATE THE LUGS ON VALVE SEATS.

FIG. *b*

DIAGRAM OF CAST-IRON BELL BEFORE POURING LEAD JOINT, SHOWING PLUG IN PLACE.

FIG. *c*

DIAGRAM SHOWING LEAD JOINT BETWEEN WOOD STAVE PIPE AND CAST-IRON PIPE, OR FITTINGS.

TO MAKE JOINT:

INSERT PLUG IN BELL AS SHOWN IN FIG. *b*

POUR LEAD JOINT AND CAULK LIGHTLY, TO ENSURE TIGHT JOINT BETWEEN LEAD AND INSIDE OF BELL.

REMOVE PLUG, LEAVING LEAD IN BELL.

DRIVE TENON OF WOOD STAVE PIPE INTO BELL, AS SHOWN IN FIG. *c*

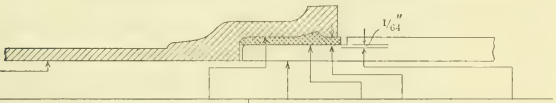
CAULK LEAD JOINT LIGHTLY IF NECESSARY.

TENON MAY BE BRUSHED WITH THIN SOFT SOAP JUST BEFORE INSERTING IN JOINT.

PLUG IS TO BE SMOOTHLY TURNED WITH TAPER OF 1/16" IN 4". OUTSIDE DIAMETER OF PLUG AT FACE OF BELL IS TO BE 1/32" LESS THAN OUTSIDE DIAMETER OF TENON OF WOOD STAVE PIPE. OUTSIDE DIAMETER OF PLUG AT BOTTOM OF BELL IS TO BE 1/16" LESS THAN OUTSIDE DIAMETER OF PLUG AT FACE OF BELL.

WHEREVER IT IS POSSIBLE TO DO SO, IT WILL BE FOUND MORE CONVENIENT TO POUR THE LEAD AND REMOVE PLUG BEFORE PLACING THE CAST-IRON PIPE OR FITTING IN THE TRENCH.

TABLE OF SIZES FOR CAST-IRON PIPE, REDWOOD OR FIR STAVE PIPE AND FITTINGS. AMERICAN WATER WORKS ASSOCIATION STANDARD.



CAST-IRON PIPE AND FITTINGS.				WOOD STAVE PIPE.			
Nominal Diameter	Class		Minimum I. D. Bell	Inside Diam. Wood Pipe	Outside Diam. Tenon	Min. Thick's of Lead	O.D. Plug at Face of Bell
	Pipe	Fittings					
4"	*BCD*	*BCD*	5.70"	4"	5 7/16"	0.145"	5 13/32"
6"	"	"	7.80"	6"	7½"	0.165"	7 16/32"
8"	*CD*	*ABCD*	10.00"	8"	9¾"	0.140"	9 23/32"
10"	"	"	12.10"	10"	11⅞"	0.255"	11 19/32"
12"	*ABCD*	"	14.00"	12"	13¾"	0.140"	13 23/32"
14"	"	"	16.10"	14"	15¾"	0.175"	15 23/32"
16"	"	"	18.40"	16"	18"	0.220"	17 31/32"
18"	"	"	20.50"	18"	20"	0.270"	19 31/32"
20"	"	"	22.60"	20"	22"	0.320"	21 31/32"
24"	"	"	26.80"	24"	26"	0.424"	25 31/32"

FIG. 8.

standardized. The details of the plug and the dimensions of the tenons were worked out by the office with the company which furnished most of the wood-stave pipe, and the other pipe-makers soon agreed to make their tenons of the same dimensions.

Fig. 9 shows, on the left, the method of frost-proofing service pipes under the floors of buildings, the intention being to provide a double air space around the pipe. It was sometimes difficult to prevent the construction forces from defeating the purpose of the device by filling these air spaces with saw-dust or other material, which, when wet, destroyed the non-conducting value of the air space. The details on the right of Fig. 9 show two methods of connecting service pipes to wood-stave mains.

Service Pipes and Fittings.

An estimate of quantities of the service pipe and fittings required for the National Army Cantonments was prepared as per Table 1 (Plate VI), which shows in its upper half the service pipe material required for each unit of each type in a divisional cantonment. The total service pipe material required for each of the sixteen cantonments is shown in the lower half of Table 1, and was readily determined when the number and type of units in any cantonment were once known.

Supplementary Schedules of Materials.

After detailed plans, based on the general plans and specifications, were worked up by the supervising engineers in the field, they would submit, as fast as possible, additional schedules of materials which might be required to complete the work, and these schedules were forwarded to the Materials Division for the purchase of the material, as soon as they had been approved by this office. To expedite the work still further, blanket authority was given in certain cases to the construction forces to purchase, without further reference to Washington, limited quantities of such specified classes of materials as could best be purchased in that manner, instead of through the usual channels.

Conditions Governing Selection of Materials and Equipment.

It may be interesting to note at this point that it was usually possible to deliver water, from the source of supply which had been selected, into storage at the camp. This storage was generally at such

TABLE 1.—ESTIMATE OF QUANTITIES OF PIPE AND FITTINGS FOR WATER DISTRIBUTION OF NATIONAL ARMY CANTONMENTS.

	Kind	Cast Iron 90° Elbow.				C. I. 45° Elbow.		Black Cast-Iron Tees.												Bushings.				Reducing Couplings.						Corporation Cock.				Gal.-Iron Pipe.			
	Size, in inches	2	1¼	1	¾	1	¾	2 × 2 × 1½	2 × 2 × ¾	1½ × 1¼ × 2	1½ × 1¼ × 1½	1½ × 1¼ × 1	1½ × 1¼ × ¾	1 × 1 × ¾	¾ × ¾ × ¾	2 × 2 × 1¼	2 × 2 × 1	1¼ × 1	1 × ¾	2 × 1¼	1½ × 1	1¼ × ¾	¾ × ¾	1¼	1	¾	½	2	1¼	1	¾
A	Division headquarters, field signal and aero squad.	3	2	2	6				3		1	3	6					1	4	3	1	6	6	3	1	6	6	[illegible]	410	833	1 070
B	Brigade headquarters				5								4	1					2									90	90	270
C	Regiment of infantry	6			12	1		1	2	7			15			1	1		9	8	2	8	1	8	2	8	1	1 350	540	870	1 650
D	Regiment of light artillery	4	2		10		2		1	4			6		1		1		3	4	2	2	17	4	3	13	17	850	1 065	340	2 340
E	Regiment of heavy artillery	3	1	2	14					4			7	4					2	3	3	5	11	3	3	5	11	590	710	645	1 005
F	Regiment of engineers with train	4	3		10			1	6	3			4	7					2	6		4	9	6		4	9	750	280	475	1 070
G	Aero squad				2					1										1	1	2		1		2		150		220	220
H	Headquarters train				4								3						1	4						3			300	380	685
I	Ammunition train	2	2	1	8			1	2	2	1		3						2	3	3	3	2	2	16	3	2	480	360	885	1 400
J	Supply train			2	2			1		2			1	1					6	5	1	3	2	4	1	3	4		180	290	710
K	Sanitary train	4			5		4			4				3						4		4	1	8		8	5	600		1 020	1 560
L	Balloon company		1		4															1	1	1	1	1		1	1		120	190	140
M	Telegraph company				6															3		1	4					150		535	410
N	Hospital unit			18	48		4					2	1	1		6	17		14	19		6	41			8	41		9	680	2 800	4 000
1	Ayer, Mass	88	15	9	231	10	10	13	31	112	8	1	27	217	4	6	5	10	30	151	114	31	123	120	114	31	123	120	18 100	11 375	14 950	32 690
2	Yaphank, N. Y.	88	15	8	235	10	10	13	31	112	8	1	27	215	4	6	5	10	30	148	113	31	119	120	113	31	119	120	17 990	11 375	13 715	32 810
3	Wrightstown, N. J.	90	15	10	243	10	10	13	31	111	8	1	24	219	4	6	5	10	32	152	116	35	125	132	116	35	125	132	17 980	12 105	14 560	33 355
4	Annapolis Junc., Md	98	17	9	253	11	10	13	31	98	8	1	27	214	4	6	5	10	32	147	115	30	118	119	117	30	118	119	17 960	11 295	13 885	32 070
5	Petersburg, Va	102	16	10	265	12	10	13	35	115	8	1	24	249	4	6	5	12	34	170	123	38	140	132	132	38	140	132	19 060	13 165	16 445	36 515
6	Columbia, S. C	94	15	9	243	11	10	13	33	106	8	1	27	232	4	6	5	11	31	164	122	33	132	121	122	33	132	121	19 450	11 915	15 190	34 270
7	Atlanta, Ga	93	14	8	231	11	10	14	33	104	8	1	27	228	4	6	5	11	31	155	120	32	124	120	120	32	124	120	19 150	11 795	14 175	33 490
8	Chillicothe, Ohio	87	14	9	235	10	10	13	31	98	8	1	27	215	4	6	5	10	30	149	113	30	120	119	115	30	120	119	17 950	11 255	13 840	32 390
9	Louisville, Ky	97	15	9	229	12	10	13	35	114	8	1	30	239	4	6	5	12	30	169	125	31	127	110	125	31	121	110	20 000	11 625	14 400	34 075
10	Battle Creek, Mich	85	13	6	205	10	10	13	31	94	8	1	30	209	4	6	5	10	28	142	109	27	111	108	109	27	111	108	17 300	10 545	13 660	30 773
11	Rockford, Ill	87	14	8	219	10	10	13	31	97	8	1	27	218	4	6	5	10	30	146	112	30	118	119	112	30	116	119	17 800	11 355	13 805	31 780
12	Little Rock, Ark	91	13	6	217	11	10	14	33	101	8	1	30	224	4	6	5	11	32	151	117	29	119	109	117	29	119	109	18 650	11 085	13 580	32 425
13	Des Moines, Iowa	104	16	9	263	12	10	15	35	115	8	1	24	249	4	6	5	12	34	171	132	37	141	132	132	37	141	132	21 150	13 045	16 225	38 495
14	Fort Riley, Kans	105	14	8	261	13	10	16	37	119	8	1	27	260	4	6	5	13	31	176	137	33	164	132	137	33	164	132	23 000	12 875	16 460	37 140
15	Fort Sam Houston, Texas	100	14	6	245	12	10	15	35	112	8	1	27	244	4	6	5	12	32	165	129	34	154	121	129	34	154	121	20 650	13 335	15 295	35 370
16	American Lake, Wash	106	17	12	291	15	10	15	35	120	8	1	33	263	4	6	5	13	36	183	138	42	152	145	138	42	152	145	23 100	13 995	17 910	38 630
	Total quantities required	1 509	223	132	3 814	176	160	221	528	1 739	128	16	458	3 715	64	96	80	176	496	2 530	1 942	523	2 064	1 950	1 942	523	2 064	1 950	307 200	191 000	235 365	543 570

Nozzs.—All fittings black cast iron. All pipe standard galvanized wrought steel.

STANDARD DETAILS OF PROTECTION FOR FIRE HYDRANTS, HYDRANT WRENCH, CONNECTING SERVICE PIPE TO WOOD MAIN, FROST-PROOFING FOR VERTICAL PORTION OF SERVICE PIPE BETWEEN GROUND AND FLOOR OF BUILDING.

STANDARD PROTECTION FOR FIRE HYDRANT.
4′6″
15½″ rail
4′6″
6″ post 6′0″ long
Set 3′0 in ground
posts to be
painted white
STANDARD HYDRANT WRENCH.
⅞″ R.
2″
17″
⅞″ R.
1 9/16″
8¾″
Make of cast or forged steel
1″
FROST-PROOFING FOR VERTICAL PORTION OF SERVICE PIPE BET. GROUND AND FLOOR OF BLD'G.
12″ x 1″
6″ x 1″
12″ x 1″
Tarred or roofing paper to be nailed all around outside of each box.
These air spaces must not be filled with sawdust, paper, or any other material.
PLAN
Floor
1″ x 1″ cleats
6″ x 1″ cleats
12″
Nail cleats to floor and to top of boxes.
Strips of tarred or roofing paper to make seal all around between tops of boxes and bottom of floor.
Both boxes to be set at least 12″ in the ground.
CONNECTING SERVICE PIPE TO MAINS.
Thread for wood stave pipe.
Standard iron pipe thread.
Black wrought steel service pipe.
Fir
Wood stave pipe
Reducing coupling.
Corporation stop-cock.
For 2½″ service pipe use corp'n stop-cock inlet 1½″ outlet 1½″
" 2″ " " " " " " 1½″ " 1½″
" 1½″ " " " " " " 1″ " 1″
" 1″ " " " " " " ¾″ " 1″
" ¾″ " " " " " " ¾″ " ¾″
Thread to fit female thread in saddle.
Saddle.
Redwood
Wood stave pipe
Bore hole in W.S. pipe and insert corp'n cock before laying pipe, as splintering, inner end of hole may thus be avoided and augur cuttings removed.
CROSS-SECTION OF PIPE WITH SADDLE.

FIG. 9.

an elevation that the pressure available was sufficient for the domestic needs, and booster pumps were provided, where necessary, to raise the pressure and increase the volume available during the times of peak load and during fires. In order to conserve steel, redwood tanks of 100 000 and 200 000 gal. capacity were in most cases utilized to furnish the necessary storage. These tanks could be shipped from California within a few hours of receipt of order, and could be quickly erected. They cost much less per gallon of capacity than either steel or concrete construction. All distribution mains were looped, the only dead ends being on the 6-in. pipe extending down into the corrals to furnish water to the water troughs. A hydrant was set on the end of each of these 6-in. pipes, but the only structures in the neighborhood were the skeleton sheds or shelters for the animals, and the value of these sheds did not justify any considerable outlay for fire protection. These 6-in. pipes, therefore, were essentially service pipes rather than mains.

In planning the fire protection it was deemed wise, in view of the size, character, and distribution of the buildings, to provide plenty of hydrants, so that there might be a large number of small streams with pressures sufficient to give good horizontal projection or reach, and placed so as to make it unnecessary to use any hose longer than 300 ft. The hydrant branches themselves were only 18 in. long, and the friction saved by reducing their length justified the use of 4-in. pipe for the branch, feeding a hydrant with two $2\frac{1}{2}$-in. hose outlets. The nozzle tips were $\frac{7}{8}$-in. in diameter, and the combination thus used accomplished the desired purpose of providing a large number of streams quickly available through short lengths of hose, and with first-class pressure right up to the nozzle tip.

The use of wood-stave pipe, which was made compulsory by the necessity of conserving steel and iron and of completing the camps by September 1st, 1917, resulted in a large saving of money. Much of the pine pipe manufactured east of the Mississippi proved unsatisfactory, and, generally speaking, it was not as good as the pipe from the Pacific Coast. Of the latter, experience would seem to indicate that redwood was superior to fir, and that the air-dried was superior to the kiln-dried redwood. Having in mind the fact that experience proved that wood pipe of good quality, properly laid, showed very little leakage, and that the life of such pipe, thus laid, may safely be taken

at about 20 years, it would have been wise, in the writer's opinion, to use this pipe for the camps, simply on account of the saving in cost and time of delivery, even had there been no restriction on the use of cast-iron and steel pipe.

Sanitation.

Although the importance of having the water supply completed by September 1st, 1917, demanded the utmost speed, the question of the sanitary quality of the supply was never overlooked. This office constantly kept in touch with the Sanitary Corps of the Medical Corps of the Army, and there was at all times the fullest possible co-operation with the officers of that corps. Whenever there was the slightest suspicion of danger of pollution, the office that discovered it first immediately informed the other, and both then united in a determined effort to remove the danger.

Great credit is due to the supervising engineers, as well as to the engineers for the contractors, and to the sanitary officers assigned to the camps, for the efficient manner in which they safeguarded the purity of the temporary water supplies used during the construction period.

In addition to the care exercised by this office in the selection of the source of supply, and in purifying the water wherever necessary, particular stress was laid on the following sanitary precautions:

(*a*) The covering of all storage reservoirs in order to prevent accidental or intentional pollution and the formation of algæ;

(*b*) The furnishing of chlorinators to all cantonments or camps, even when the supply might be regarded as normally safe;

(*c*) The prohibition of the use of wells in shallow strata on inhabited water-sheds, or in any other stratum or location in which it might be possible for the wells to become contaminated;

(*d*) The absolute prohibition of any distribution mains carrying polluted water, whether for fire protection, or industrial, or any other use; and of any outlet or fixture from which such water might be drawn; or of any arrangement that would permit the later introduction of any such outlet or fixture. This ruling was often difficult to enforce, but it was always insisted upon.

The results accomplished by the careful consideration thus given to water-works sanitation have been discussed in the technical press.*

The inoculation of the troops for typhoid and para-typhoid by the Medical Corps greatly reduced, but did not entirely remove, the danger of their contracting these forms of water-borne diseases. There was no inoculation against other water-borne diseases, and civilians were not usually inoculated at all.

Water Systems for National Guard Camps.

The work on the water systems of the sixteen National Army cantonments had only fairly commenced when it was decided, late in June, 1917, to construct sixteen tent camps for the National Guard troops. The Construction Division was ordered to have five of these camps ready to take troops by August 1st, five more by August 15th, and the remaining six by September 1st. The difficulties of the problems incident to this new construction were enormously increased by the fact that the orders for water-works materials required by the cantonments had so exhausted the available stock and overtaxed the capacity of the various manufacturing plants that it was impossible for them to furnish any considerable quantity of similar materials within the time allotted for the construction of the National Guard camps. Therefore, it became necessary to use, in so far as possible, materials which had not hitherto been drawn upon. After a conference with prominent representatives of the manufacturers of wrought-steel pipe, it was decided to use 6-in. wrought-steel pipe for the distribution mains for eleven of these tent camps, to use 6-in. cast-iron pipe for the two camps which were in the Birmingham district, and to use 6-in. redwood-stave pipe for the two camps in California and the one at Deming, N. Mex. The steel companies rolled and shipped 500 000 ft. of 6-in. steel pipe in a little more than 6 working days. The cast-iron pipe manufacturers shipped about 80 000 ft. of 6-in. cast-iron pipe within a not much greater period, and the wood-stave pipe manufacturers made correspondingly good deliveries of their product; so that a considerable part of the necessary material was on the way to the camps, in some cases before any constructing quartermaster, supervising engineer, or contractor, was on the ground, and in practically all cases before any plan showing the topography of

* Editorial in *Engineering News-Record*, April 18th, 1918, entitled "Our Military Camps Show Remarkable Typhoid Fever Record."

the camp site was available. In this matter, as in all others in which the Materials Branch of the Construction Division had a part, the efficiency of that branch was splendidly demonstrated.

Enlargement of Construction Division Activities.

As the National Army and National Guard camps neared completion, work was begun on Camp Hill and Camp Stuart, near Newport News, Va.; Camp Merritt, at Tenafly, N. J., and Camp Johnston, near Jacksonville, Fla.; the first three being embarkation camps and the last a school of instruction for quartermasters. Camp Meigs, in Washington, was also built at about this time, and then began the work of building warehouses, terminals, munition depots, arsenals, plants for the manufacture of gas, bag-loading plants, proving grounds, and all the other projects entrusted to the Construction Division, whose field of activities was enlarged to include all construction work for the Army in the United States and its insular possessions.

The construction of the embarkation camps marked a change in the size and grouping of the buildings in each unit, and the typical layout of water mains was changed to suit the new building plans, the principal change being the use of three lines of mains, instead of two, through each unit. This resulted in still better fire protection, and in a great reduction in length of service pipes.

Some Typical Working Plans.

The personnel in the office having been enlarged at about this time, it became possible to prepare drawings in much greater detail, and the office was thus enabled to make plans showing much more clearly than formerly the arrangement of pumps, motors, and piping, in or near the various pumping stations or reservoirs.

A drawing of this sort could be turned out in a very few working hours by the specially trained men in this office, and these drawings invariably saved a great amount of labor in the field. Furthermore, these layout plans, which were sent to each job with the manufacturers' detailed foundation plans for the motors, internal combustion engines, and pumps, prevented serious mistakes on the part of the construction engineers, who, while unquestionably competent in many other lines of work, were naturally often more or less unfamiliar with the special field of water-works design, and were so fully occupied with

their construction work that they could not give the time for the development of carefully studied plans.

The plans shown on Fig. 10 are for a filter plant and pumping station of very small capacity, and are reproduced here more because

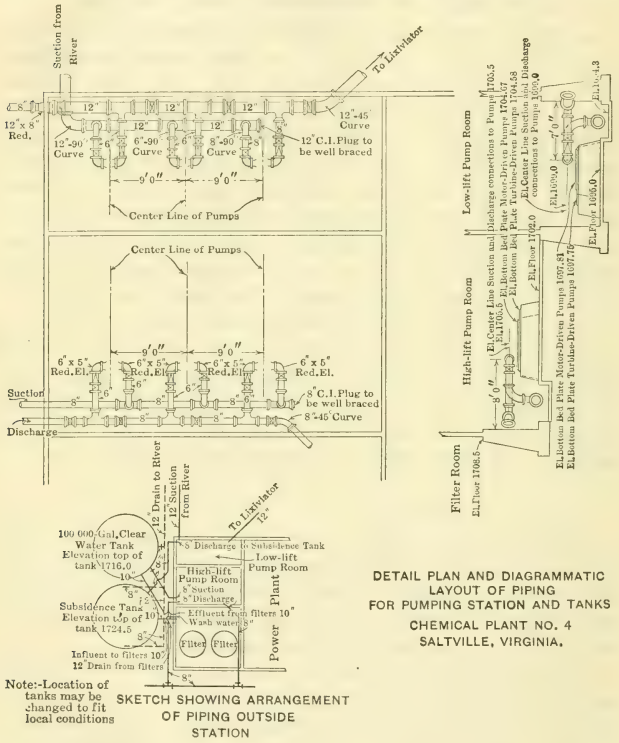
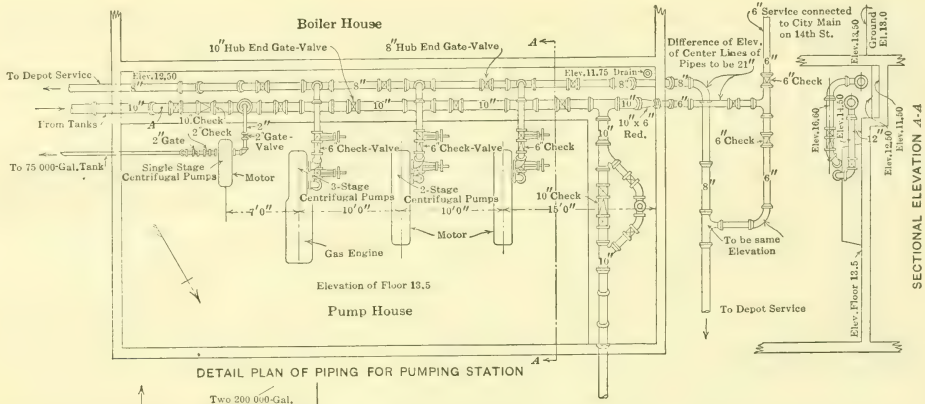
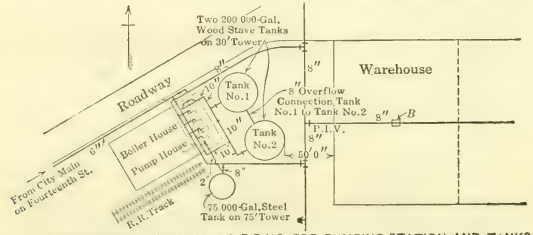

Suction from River
To Listvlator
12"x 8" Red.
12"-45° Curve
12"-90° Curve
6"-90° Curve
8"-90° Curve
12" C.I. Plug to be well braced
9'0"
Center Line of Pumps
Low-lift Pump Room
High-lift Pump Room
Filter Room
El. Floor 1706.5
El. Floor 1702.0
El. Floor 1695.0
El. Floor 1690.0
El. Center Line Suction and Discharge connections to Pumps 1703.5
El. Bottom Bel Plate Motor-Driven Pumps 1704.67
El. Bottom Bel Plate Turbine-Driven Pumps 1704.53
El. Center Line Suction and Discharge connections to Pumps 1700.0
El. 1704.3
El. 1695.0
6"x 5" Red. El.
8" C.I. Plug to be well braced
8"-45° Curve
Suction
Discharge
El. Bottom Bel Plate Motor-Driven Pumps 1697.81
El. Bottom Bel Plate Turbine-Driven Pumps 1697.76
12" Drain to River
12" Suction from River
To Listvlator 12"
100 000 Gal. Clear Water Tank Elevation top of tank 1716.0
8" Discharge to Subsidence Tank
Low-lift Pump Room
High-lift Pump Room
8" Suction
8" Discharge
Power Plant
Subsidence Tank Elevation top of tank 1724.5
Effluent from filters 10"
Wash water 8"
Filter
Filter
Influent to filters 10"
12" Drain from filters
Note:-Location of tanks may be changed to fit local conditions
SKETCH SHOWING ARRANGEMENT OF PIPING OUTSIDE STATION
DETAIL PLAN AND DIAGRAMMATIC LAYOUT OF PIPING FOR PUMPING STATION AND TANKS
CHEMICAL PLANT NO. 4
SALTVILLE, VIRGINIA.

FIG. 10.

the plant was an unusually complete one than for any other reason. It will be noted that there was a small sedimentation tank, two filter tanks, a clear-water tank, and three low-lift and three high-lift pumping units. It was the practice to eliminate from plans of this sort all unnecessary lines, or dimensions, or lettering, but to indicate what-



DETAIL PLAN OF PIPING FOR PUMPING STATION


Two 200 000-Gal. Wood Stave Tanks on 30' Tower
Roadway
Tank No. 1
Tank No. 2
Boiler House
Pump House
Warehouse
8" Overflow Connection Tank No. 1 to Tank No. 2
P. L. V.
50' 0"
From City Main on Fourteenth St.
R. R. Track
75 000-Gal. Steel Tank on 75' Tower

DIAGRAMMATIC LAYOUT OF PIPING FOR PUMPING STATION AND TANKS

DETAIL PLAN AND DIAGRAMMATIC LAYOUT OF PIPING FOR PUMPING STATION AND TANKS. BALTIMORE DEPOT WAREHOUSES.

Note:-All gate valves within pump house to be outside Screw and Yoke. Pilot tube from altitude valve to be connected to 10' suction main at *A*.

FIG. 11.

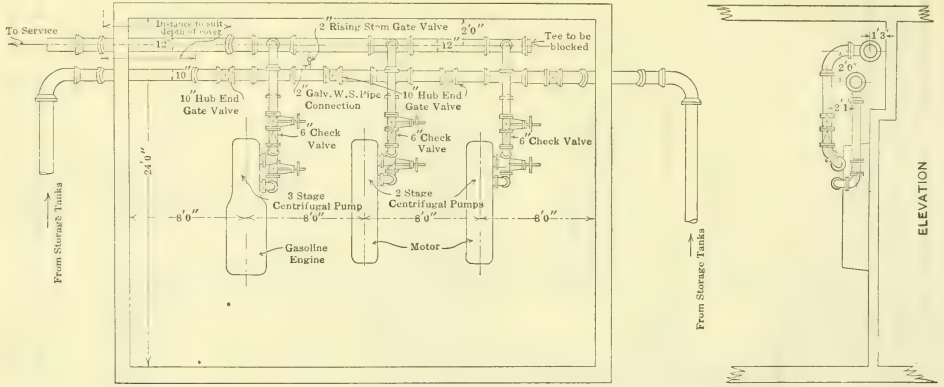
ever was shown so clearly that the drawing could be easily understood by the men in the field.

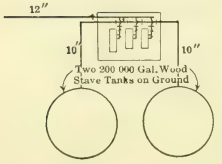
Fig. 11 shows plans for the pumping station, storage tanks, motor-driven pumps, gasoline-engine-driven pump, and piping and connections. In this case the supply came from a city main, the water from which flowed into the first of two wooden tanks, each having a capacity of 200 000 gal. The pipe connections were arranged so that the first tank was always kept full, the second tank being filled only by the overflow from the first one. In this way there was always at least 200 000 gal. of storage for fire purposes, in addition to whatever storage might happen to be in the second tank, which took care of the peak loads due to domestic use, and in addition also to such supply as the city mains might be capable of delivering to the suction of the fire pumps. The small pumping unit was utilized to keep the small sprinkler tank full at all times.

The pumping station and tanks shown in Fig. 12 were for fire service only. The supply in this case was from wells, and the ordinary domestic pressures carried were more than sufficient to fill the two 200 000-gal. tanks adjacent to the pumping station, so that there were always at least 400 000 gal. in reserve for extinguishing fires. There were two electrically-driven and one gasoline-engine-driven centrifugal fire pumps, taking their supply from the tank.

Fig. 13 shows plans for pumping station and tanks, in which it will be noted that there are two 200 000-gal. storage tanks near the surface, and a 75 000-gal. elevated steel tank. The supply was taken from the city mains, the pressure in which was sufficient to fill the low storage tanks, but not always sufficient to put water in the elevated tank; and a booster pump was provided to fill the latter and give the necessary domestic pressure. In case of fire the two fire pumps could take their supply from the two 200 000-gal. tanks, supplemented by such water as might come in from the city's mains.

It will be noted that practically all the regular service pumps were motor-driven centrifugals. These were operated, as a rule, by purchased current. Steam machinery and electric generators could not be had, whereas electric motors and centrifugal pumps were obtainable on reasonably short notice, and the combination made the cheapest of all pumping units. At least one internal combustion engine was usually provided as a reserve against a break-down in the electric service.





DIAGRAMMATIC LAYOUT OF PIPING FOR PUMPING STATION AND TANKS

Note:-All gate valves inside of Pumping station to be outside Screw and Yoke

DETAIL PLAN AND DIAGRAMMATIC LAYOUT OF PIPING FOR PUMPING STATION No. 2 AND TANKS CURTIS BAY ORDNANCE DEPOT CURTIS BAY, MD.

FIG. 12.

Bell and spigot pipe and specials were used wherever possible, because material of this class gave greater flexibility for making connections, cost less, and could be more quickly obtained, than any other.

Plate VII is a plan of a 2 000 000-gal. filter plant and pumping

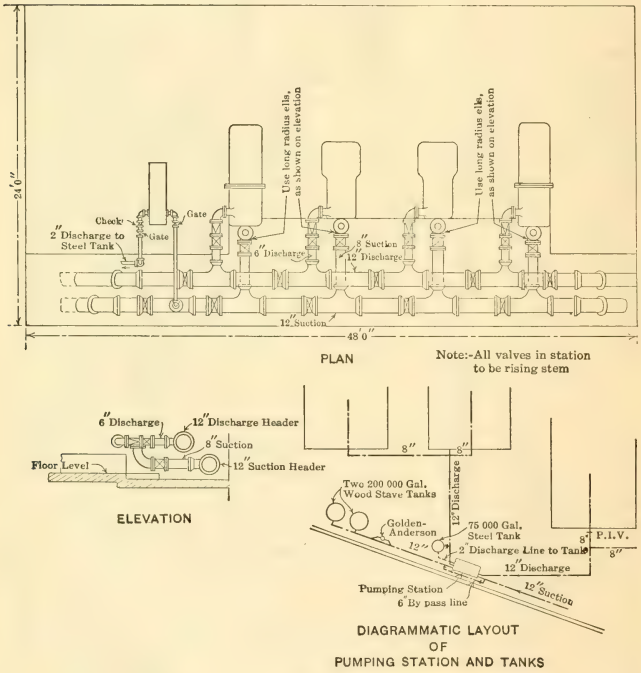
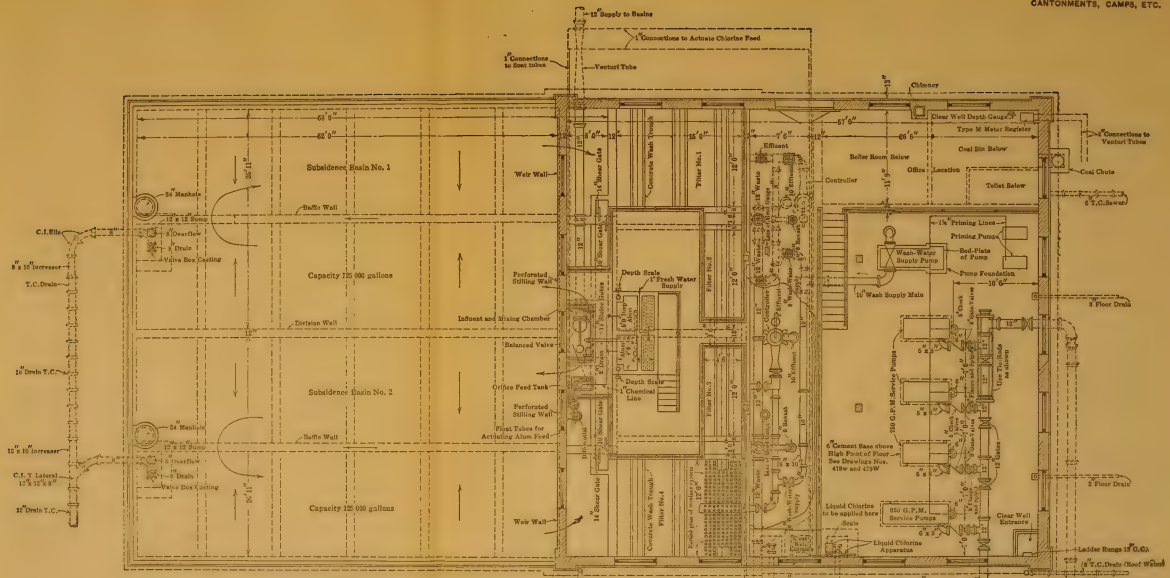


FIG. 13.

station. This plan was prepared by the contractors for the filter equipment, in accordance with instructions from the writer, and embodied two somewhat unusual features, both of which had been previously incorporated in plants designed by the writer before the war, and while he was still in private practice.



NOTE

Combined capacity of subsidence basins equals 250 000 gallons 3 hours subsidence at 2 000 000 gallons rate.

GENERAL LAYOUT OF FILTRATION PLANT
CAMP A. A. HUMPHREYS
VIRGINIA.

The first of these features was the arrangement of the mixing chambers and sedimentation basins. It will be noted that there were two sedimentation basins, each of which had a baffle-wall extending from the pumping station building toward the far end of the sedimentation basin. The two mixing chambers, one for each basin, were just inside of the rear wall of the building and near its center. The coagulant was added to the water in these mixing chambers, and the water in each basin then flowed away from the building around the end of the baffle-wall and back again to an effluent chamber similar to the mixing chamber, and likewise enclosed within the walls of the building. Large windows in the rear wall of the building provide abundant light over the mixing and effluent chambers, and it is thus possible for the filter operator, without leaving the building, to study, side by side, the influent and effluent water, and thus obtain an excellent idea of the way in which the floc is forming. This is a feature which has always appealed strongly to every filter operator.

Another somewhat unusual feature of the design of this plant is the open pipe gallery, which has the same advantages over the usual dark and concealed pipe gallery that open has over concealed plumbing.

In addition to the wash-water pumps, there are three electrically-driven and one gasoline-driven centrifugal pumps, all in the same main room as the mixing and effluent chambers, filter tanks, operating platform, and pipe gallery; and the whole plant is thus about as compact and accessible as it would be possible to make it.

The illustrations accompanying this paper show less than 1% of all the water-works plans prepared in the Washington office. They were selected for reproduction because they gave a fair idea of the general character of the work done. It should be noted, however, that none of the larger projects is shown, the plans for these being so large that they could not well be reduced to a scale suitable for reproduction in this paper.

Consumption of Water.

The determination of the quantity of water to be supplied to the National Army camps has already been mentioned. The specifications provided that the water-works systems should be capable of furnishing at all times at least 55 gal. per capita per day. This included an allowance of 15 gal. apiece for the horses and mules. As there was

about one animal for every three men in a divisional unit, the net allowance per man was 50 gal. per day.

This is about 80% more water than was supplied in the British, French, Belgian, Canadian, or German cantonments, and is larger than the quantity recommended by Capt. Francis C. Harrington.*

It is a well-recognized fact that Americans use, and waste, more water than any other nation; but there are many cities in the United States, where meters are in fairly general use, and in which the average daily per capita consumption is less than 50 gal., including all water wasted, leakage in mains and service pipes, water for flushing sewers, sprinkling lawns and streets, public and private fountains, the water used by the Fire Department, and all sorts of industrial, commercial, and manufacturing uses, these latter being often quite large in quantity; in fact, every drop of water that enters the distribution mains at the pumping station.

The experience of the Construction Division with the Army Camps proves conclusively that the allowance of 55 gal. per capita per day to such camps was a very liberal one. A little study will show that it would be almost impossible for any man to use legitimately more than 20 to 25 gal. per day, and that all water used in excess of this quantity must represent leakage and waste. It is impossible to stop all leakage and waste, but it ought to be, and is, easy in such camps to keep the total consumption down to twice the maximum legitimate quantity actually required by the men.

When the sixteen National Army camps were first occupied there were only a few of them in which the consumption of water exceeded 55 gal. per capita per day, and in several cases the daily per capita consumption was less than 40 gal. At this time there was practically no check on the use or waste of water, as the utilities organization had not yet been perfected. Furthermore, it was not then possible to secure effective utility management, by reason of the fact that the utilities officers had to report to the Camp Quartermasters, which meant that they were under the Commanding Officer at the camp. As the chief interest of these Commanding Officers was to train troops for France, they were quite naturally not always willing to furnish the utilities officers with a sufficient personnel of non-commissioned officers

* In his paper on this subject, published in *Professional Memoirs*, Corps of Engineers, Vol. 8, No. 39.

and enlisted men to maintain the utilities in proper operating condition and to check leakage and waste. During the severe winter of 1917-18, the daily per capita consumption increased greatly in most camps, and in some instances exceeded 100 gal. This was due partly to leaks in plumbing, but largely to the fact that water was allowed to run to waste to prevent freezing. In the four most northerly camps, which had central heating systems, the water used for heating was not returned but was blown to waste, and the water wasted in this manner alone amounted to 600 000 gal. per day per camp during cold weather. By the end of the winter the utilities organizations in each camp had begun to attain their stride and make their influence felt, their efficiency being increased enormously by the fact that they were now reporting to the Maintenance and Repair Division of the Construction Division, instead of to the Commanding Officers at the camps.

In the early summer of 1918, orders were sent to the Commanding Officers at every Government activity, instructing them to co-operate in every way possible with a view to checking leakage and waste of water. The effect of these orders was soon apparent, and at practically all the camps the daily per capita consumption was reduced to less than 55 gal. without the slightest inconvenience or shortage of water for any one. As time permitted, the utilities officers, working under the direction of the Maintenance and Repair Division of the Construction Division, conducted water waste surveys and made frequent inspections and repairs of plumbing. This work not only greatly reduced the waste of water, but showed conclusively that the excessive consumption was due almost entirely to waste and to leaky fixtures, and that the underground leakage was almost invariably negligible.

Changes in National Guard Camps.

When the National Guard camps were originally laid out there were no barracks, the men being quartered in tents; and there were no sewerage systems. This meant that there was no necessity for providing either the same standards for fire protection, or the same quantities of water, as were called for by the National Army camps, an allowance of 30 gal. per capita being ample for them. Nevertheless, in laying out the distribution systems for these camps, the possibility that they might ultimately have sewerage systems, and that they might have to be converted from tent camps to barrack camps, was not over-

looked, and the two lines of 6-in. distribution mains running through each unit in the camp were laid along the outer edges of the units and in such manner that, later, should the changes just referred to be made, the water-supply systems could be quickly brought up to the standards then required by laying an additional main of larger size through the center of each unit.

Early in 1918, the officers in charge of the Construction Division foresaw the probability of improvements in the National Guard camps. No orders for such improvements had been issued, however, and no funds were available. The one thing that seemed certain was that, when the orders did come, the changes would have to be made in a hurry. With a view to being prepared to reinforce the distribution systems in the Guard camps with the least possible delay whenever the order should come, this office endeavored to arrange some plan by which the necessary redwood pipe might be manufactured and shipped from California to some advantageously situated eastern point from which immediate deliveries could be made to the various National Guard camps. Unfortunately, however, there was no authority for any such action.

After nearly 2 months had passed in fruitless efforts to perfect the arrangement just referred to, that plan was abandoned, and it was decided to place an order for 300 000 ft. of redwood stave pipe of assorted sizes for the account of a large Quartermaster terminal project which had been recently authorized and the funds for which had not yet been drawn upon to any great extent. It was the intention to have the pipe actually made and shipped to this Quartermaster terminal, and thereafter to divert it, either in transit, or by shipment from the Terminal, to the various camps, to the account of which it could then be charged.

In the meantime plans were prepared in this office for the reinforcing of the distribution system and for such other changes in the water supply systems at the camps as might be rendered necessary by their conversion from tent camps to barrack camps and by the introduction of sewerage systems.

In August, 1918, this office was ordered to prepare immediately estimates of the cost of the changes in the water supply system of twelve National Guard camps, incident to the changes above referred to; and with the plans for these changes already prepared, the office

was able to deliver the estimate required within 2 hours. Practically none of the pipe ordered for the account of the Quartermaster terminal, but actually required at the National Guard camps, ever reached the terminal. At the time of the shipment of this pipe the freight congestion on the railways was greater than ever before in the history of the country, so that it took from 6 weeks to 2 months to deliver pipe from the Pacific Coast to points east of the Mississippi River. A very serious delay was avoided in the manner just described.

Contracts for Water Service and for Extensions.

In a great many instances the water supply for the Government activities was taken from existing water-works systems which were owned either municipally or privately. In all such cases, special contracts had to be made for water service, and whenever the quantity of water desired was large, it was almost invariably necessary to embody in the contract for water service provisions for extensions to the existing plant, in order to enable it to meet the increased demands.

It was usually impossible for the owners of the existing system to finance the desired improvements, and these contracts, therefore, provided that the Government would make the required extensions and turn them over to the Water Department for operation as soon as they were completed. The contracts also provided that, within a certain reasonable time after the termination of the war with Germany, the owners of the existing plant should purchase the extensions from the Government on terms which fully recognized the fact that the extensions were made as a result of the emergency occasioned by the war. The interests of the owners of the existing water systems were thus fully and fairly recognized.

As a general rule, the rates paid by the Government for water service were unusually low, especially in view of the enormously increased cost of furnishing the supply. In practically every instance the rate at which water was sold to the Government was the lowest on the local schedule, and in many cases the Government rate was made lower than the lowest schedule rate, a condition which was usually justified by the fact that the Government was the largest local consumer. So far as the writer's recollection serves him, there was no large Government

activity which paid in excess of 15 cents per 1 000 gal., this rate being paid in one instance for water which had to be pumped three times, filtered, and chlorinated. The lowest rate paid for water was 4¼ cents. In many instances the rate was less than 8 cents.

A number of contracts were drawn in which other departments, such as the Navy, the Shipping or the Housing Corporation, were jointly interested with the Army; and these contracts involved negotiations with the several departments, as well as with the owners of the existing water systems.

Summary.

The office of the Advisory Engineer for Water Supply, Construction Division, has handled for the various branches of the Government, water supply problems on more than 275 different projects, involving the construction, in round numbers, of nearly 1 100 miles of mains from 6 to 30 in. in diameter; 700 miles of service pipes from ¾ in. to 2½ in. in diameter; 650 000 000 gal. per day in pumping capacity; 67 000 000 gal. in capacity of concrete, steel, or wood reservoirs or tanks; 3 000 000 000 gal. capacity in impounding reservoirs and more than 40 000 000 gal. daily capacity of filters.

In an article prepared by the writer* late in 1917, the following statements were made with reference to the cost of the water-works systems for the sixteen National Army Cantonments:

"It may also be stated that the cost of reproduction new of the average water-works system in a city of 40 000 inhabitants, at present prices for materials and labor, and exclusive of service connections, would average over $2 000 000, or more than $50 per capita. As nearly as can be ascertained at present, the cost of the water-works of the 16 National Army cantonments, including service connections to within 5 ft. of the buildings, has been less than $11 per capita, or say about one-fifth as great as the reproduction cost new to-day of the average municipal water-works system.

"Perhaps 25% of this great difference in cost of the entire system is due to the fact that about 70% of the distribution mains have been wood-stave pipe instead of cast-iron pipe, the cost of wood-stave pipe being on the average about 60% of that of cast-iron pipe. The greater density of population in the camps has also contributed materially to reduce the cost of their water-works. But when every possible allow-

* *Engineering News-Record*, January 3d, 1918, p. 35.

ance has been made, the comparison of cost cannot be other than favorable to the camps.

"Finally, and infinitely more important, is the time comparison. The time allowed for planning and completing a water-works system for a city of 40 000 population would, under ordinary circumstances, be about three years; whereas with the most difficult material, labor and transportation conditions ever known in this country, the water-works for the 16 Army cantonments have been planned and completed in a little over three months."

From the nature of the case it has been impossible to secure any data, even approximately accurate, of the cost of later water-works systems built by the Construction Division. There can be no doubt of the fact, however, that the unprecedentedly bad weather conditions in the winter of 1917-18, the epidemic of influenza, and, above all, the constantly increasing cost of labor, coupled with its steadily diminishing efficiency, have all combined to increase the cost of work, not only on the projects carried out by the Construction Division, but on every project of whatever nature that has been undertaken in the United States.

In round numbers, about 4 000 000 troops and 2 000 000 civilians have been supplied with water by plants designed and built by the Construction Division. Up to date, this office has not been informed of any case of typhoid fever or other water-borne disease which has been attributed to any of these water supplies.

The barracks, mess halls and lavatories built by the Construction Division were necessarily of frame construction, and, therefore, very inflammable. Many thousands of fires have started, but in only three cases has a fire escaped beyond the building of origin. In each case the fire department at the camp succeeded in saving a part of the barrack building in which the fire originated and a part of the mess hall to which it spread. These fires were extinguished by the outside fire protection afforded by direct pressure from the water-works systems in the cantonment.

The records for 1918 show that the per capita loss by fire throughout the United States was $2.70, whereas the total per capita loss by fire at the Construction Division activities for the year ending June 30th, 1918, was only 67 cents.

The writer trusts that he has already made it clear that the work described in this paper was in no sense a one-man job. It would seem evident that results such as have just been set forth could not have been achieved without the loyal and intelligent co-operation of every one of the many men who bore a responsible part in the work, not only in the office, but in the field.

AMERICAN SOCIETY OF CIVIL ENGINEERS
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ADDRESS AT THE ANNUAL CONVENTION IN ST. PAUL AND MINNEAPOLIS, MINN., JUNE 17TH, 1919.

By Fayette S. Curtis, President, Am. Soc. C. E.

For the last two years the Annual Convention of the Society has been omitted on account of the war; therefore, the Presidential Address has been delivered at the Annual Meeting in January. The fact that we are again in a position to resume our Convention meetings is, I am sure, a source of unbounded gratification to all.

In this address I ask pardon if I digress somewhat from the trend of former addresses and speak of the fundamental principles of the engineer, his duties, what he has accomplished and can accomplish in the future, the application required to make work successful, and the distinction that may be gained through uprightness and honest labor.

It is quite probable that some of you have often been asked the question: "Do you recommend Civil Engineering as a profession?" and I assume that generally an affirmative answer has been given. The civil engineer, when thoroughly fitted for his profession, immediately becomes useful to society and the world of materiality. He is prompted by the wants of society, and is constantly originating other wants by the improvements he introduces. He is also creative, and his profession is not mortgaged to power or influence, but stands firmly on its own foundation—encouraged by world-wide influences.

His duty consists in designing, arranging, and building structures or machines which require the immediate superintendence of those who are acquainted with not only the principles but the practice of con-

struction; for engineering is a branch of knowledge that takes its place both among the Sciences and the Arts.

Therefore, to be eminent in his profession, or any branch of it, he should be able, not only to design and plan, but to supervise construction. Those who have only the knowledge of how to design and plan, and are unable to execute, become confused in meeting the many contingencies which arise.

The profession, embracing as it does almost every kind of construction, requires a very extensive and general acquaintance with other sciences, in order that the engineer may be qualified to accomplish successfully the various works on which he may be engaged, and to overcome those difficulties which frequently arise unexpectedly in the progress of his work, and, but for that knowledge and talent, threaten its final success.

Thomas Telford, in his "Descriptive Narrative of his Professional Labours", has said:

"How can a man give judicious directions unless he possesses personal knowledge of the details requisite to effect his ultimate purpose in the best and cheapest manner? It has happened to me more than once, when taking opportunities of being useful to a young man of merit, that I have experienced opposition in taking him from his books and drawings, and placing a mallet, chisel or trowel in his hand, till, rendered confident by the solid knowledge which experience only can bestow, he was qualified to insist on the due performance of workmanship, and to judge of merit in the lower as well as the higher departments of a profession in which no kind or degree of practical knowledge is superfluous. For this reason I ever congratulate myself upon the circumstances which compelled me to begin by working with my own hands, and thus to acquire early experience of the habits and feelings of workmen; it being equally important to the Civil Engineer, as to Naval or Military Commanders, to have passed through all the grades of their profession."

It is no doubt true that many men have gained prominence in their profession by individual effort—practicing and studying at the same time, with a view to acquiring a full knowledge of all necessary scientific principles. Students are required to spend a certain time in acquiring technical knowledge, but must not then think they are

engineers in the broad meaning of the term, capable of constructing and being responsible for engineering work, as that is a false idea.

No one can doubt that the addition of the natural sciences to the old-time arts course has greatly enriched it, and the sciences are now undoubtedly the most important part of a liberal education; but there is another side, which we cannot ignore, and that is, that after all, the great object of a good education is not so much the accumulation of knowledge as the development of mental power in the individual.

The tendency toward scientific and practical education is no new thing. Men have come to see that the first mental training can be made more effective by solving physical problems than by studying the dead languages, because as much true value can be obtained in the study of Nature as in the study of man's conception of Nature. First knowledge is more satisfactory to the best of minds.

The profession has become so diversified that after having secured a good fundamental training it would be worth serious consideration to take up a single branch of engineering practice, as it can hardly be expected that the civil engineer will become proficient in every branch. He would be better able to give his best endeavors to attaining the highest proficiency in some particular line, and, at the same time, grasp or understand in a general way the subjects which may relate to the several kinds of works, as the whole subject is so broad that it would be vain to attempt to understand them all in all their details.

Ambition to obtain as great a knowledge as possible is to be admired and encouraged, but to attain the highest standard in one branch is more commendable than to attempt to reach special eminence in all, as the student will be apt to find himself oppressed with a weight which he is not capable of sustaining, and this will be very likely to result in utter failure.

The professional man should not make the mistake of thinking that he can reach the top in an unconcerned and idle manner, believing that by some easy process he will reach and hold it. The structure on which he stands must be constructed by piece and parcel, every member thoroughly tested by a gradual and difficult process; he must experience all the difficulties, trials, and troubles to be met on the way, in order to support and sustain him at the higher elevation to which he aspires. To such the doors to success are open. Work seeks the best hands, as naturally as water runs down hill, but seldom seeks one whose only recommendation is that he needs it. If he is not willing

to go slowly through the maturing process of time, through patient work, by steady application step by step preparing himself for the work ahead, which has made men prominent and efficient in their profession, then, alas, the result is doubtful. It is like the student who prepares his education for future advancement. He goes from grade to grade until he is master of the science on which he has to build, taking no upward step until the last has been tested and found not wanting in any characteristic which will sustain him and serve him to build on for the future.

New problems are all the time arising. The tremendous growth of our complex industrialism means the facing of new conditions, that we may overcome new difficulties and enjoy new benefits. Therefore, there is only work to face, and it should be met with a spirit characteristic of the creator of science, and thereby much may be accomplished.

There is no success without hard and earnest labor. Never balk at a few obstacles, but hang on with all your might; this, in the end, will give success. It is true that many experiments will have to be made, but there can be no doubt of ultimate success if our aim is a determination to succeed and we do not become discouraged.

As we look back, even over a short time, how often have we said to ourselves, after completing some important structure, "This should last for many years—we have reached the limit;" but within a comparatively brief period have we not seen that structure replaced by another, larger and more expensive, which has been demanded by the growth of business? We have not stopped building, nor have we come to the time when we have built sufficiently for the future, and we never will, as long as the richness of this country is undeveloped and its physical and financial growth continues. To stop this great advancement, which the people continue to make, would be death. Then, does it look as though there was not a future for the engineer who has integrity and perseverance, as he is and must be the practical foundation or basis for all which we are to build, in order to accomplish a higher and nobler position in society?

The work of the engineer is the foundation on which rests the growth of this great Republic, not only physically but financially. He is one of the prime factors, and could not by any possibility be dispensed with. We are not an organization which threatens to pull

down and wreck or destroy what we have built, but an educational organization, and hope to get the necessary recognition of our rights through education. No doubt the engineer has often had his line of procedure curtailed by some power having authority to suspend or discharge at will, at the pleasure of some controlling power, ignorant, and with no understanding of the conditions or the difficulties the engineer may have to meet, and without the least knowledge of engineering subjects.

Civil engineering is ages old, but has always shown a steady progression, possibly not as to more substantial work, but certainly in the facilities provided in machinery to do its work. As to its beginning, I will not undertake to say, but will only refer back to those times of which we may have knowledge, and ask if the great work done is not a credit to the scientific ability of this profession? But what is the future to be? Does it depend on those who are coming into this Society —educated, experienced—to show to the world that they can and will continue to build and improve the financial and social conditions? For a determination we must wait on time.

Is the engineer being benefited by his connection with this Society? It has been said that the Society is becoming less democratic and more conventional, or, in other words, is not taking sufficient interest in, or having proper regard for, its members, and, therefore, they are without the opportunities or advantages which they might gain in local societies. This Society has grown to such an extent that contact personally with all its members is not possible, but the interest and devotion and brotherly love of its members are just as great as ever. The information in the different papers by the most prominent engineers of the country, presented and distributed, is of the greatest importance to the members of the Society. As the Society grows, this information increases, and the papers are more numerous and contain information and knowledge which cannot be obtained except through the parent society. If not, why are so many engineers anxious to affiliate themselves with this Society? They know it gives them prestige the world over, and sets a standard which has been passed upon and approved by the highest of professional men. Our Constitution requires that standard to be higher than that of any of the local societies.

The Society has not only grown in numbers, the increase within the last ten years being 85%, but has increased in influence in the estimation of the public and the world at large; our members are looked up to as the leaders in the Engineering Profession. Then, who can say that it, as an engineering society, has depreciated, gone back, or fallen off one iota from its former standing? On the contrary, it has grown steadily stronger and stronger. Its members have become of such strength, in the material and financial upbuilding of the Government, that they are indispensable.

Therefore, we must not permit ourselves to forget the obligation we owe to the founders of this Society, the men who gave their time and talent in creating an organization which has proved to be of untold benefit to the Engineering Profession. How, then, are we to repay them, if not by giving to the Society our support and assistance, promoting good fellowship among its members, encouraging its officers, and giving a helping hand to the future engineer who comes into the Society, passes up through the different grades of experience, and is seeking information? Let us all do something in the interest of the Society, and thereby broaden its influence and add to its high standards of proficiency.

We certainly cannot help by creating dissensions among the members, or becoming dissatisfied with the earnest labors of those whom we select to bear its responsibilities, or in getting the idea that we are connected with this Society wholly for what we can get out of it. No matter how much we give, we can never repay the Society for the benefits we have received.

The engineer has designed and built many a monument which will endure for ages as a testimonial to his proficiency and skill. We need not go back many years to find members who have won the highest engineering distinction and whose names are ineffaceably engraved on the enduring pages of history. We know who they are and what they have accomplished. Even before this Society was organized, we find the names of engineers who achieved everlasting remembrance through their exceptional ability. Therefore, I would say to engineers, but more particularly to the younger members of the profession, that there is a future for them which, if taken advantage of, will ensure the highest honors possible to be obtained.

By him who is in the prime of life and in the possession of health, strength, and knowledge of the arts and sciences, much may be accomplished. Therefore, never give up. Think, work and suffer, that in this life you may gain something which will place your name upon the highest pinnacle of fame.

Many of our members have been engaged in the late war, and their work, in the construction of yards, docks, cantonments, and the reconstruction and building of bridges, roads and equipment, both in this country and on the other side of the Atlantic, thus making it possible to take care of millions of troops, was the most important factor in bringing the war to a successful termination. All of this has been done in such short time as to bring out comment and praise from the whole world. Why should not the engineer have his full due and credit for the ability he has shown, not only at critical moments during the war, but in the accomplishment of things at other times?

We are living in an age in which we possess all the information as to what has been done for many years, all of which we ought to profit by. The conditions change, the opportunities grow greater. This world is growing in its necessities almost beyond the imagination of the present generation. The country is being developed so that every State in the Union is increasing in wealth and prosperity. Greater facilities are needed to accommodate its growth. And yet some say there is no future!

The work of other engineering societies or organizations should also be mentioned. They have all done their part in building and developing the great industries of the world. All are working toward the same purpose, creating, building, and improving the facilities on which the prosperity of the country depends. This is illustrated by the establishment of Engineering Council, composed at present of representatives of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Society for Testing Materials, for the purpose of giving more strength to the profession and obtaining greater recognition for the engineering arts and sciences.

Why should we not go farther, and even take our position in Governmental affairs? Is it the political cloud that casts a shadow over us, so that our practical ability does not get the proper recogni-

tion in Government affairs; or is it our modest, indifferent way of being satisfied with our present condition? We should rise to the occasion, demand our rights, and a proper recognition by the people generally, with the idea that we are not only to advance the engineering arts and sciences but to fill the positions under this general Government which require the knowledge of how to govern, each according to his ability.

The Armistice having been signed, it is incumbent on us, as founders of prosperity, with the sciences and the arts, to become one of the greatest upbuilding factors in the future, to help reconstruct that which has been torn down and destroyed by the ravages of war, and to promote new ideas for the world's future prosperity.

Emerging from the greatest war the world has ever known, not only in the number of men engaged and the use of the most deadly weapons, but in the destruction of property, what does this mean for the future? The employment of many engineers to reconstruct, and to rebuild in an improved form.

In the future the names of many of you engineers will be enrolled among those who have attained high public standing through great achievements. Many in our profession have thought, done, and suffered much in former days. Childhood may seem to be at almost an immeasurable distance in the past, but something that we have accomplished on account of its overpowering vastness seems near. It is like a beacon light, far away but seemingly near.

It is said, "The schoolhouse of the world—human experience—however expensive, has something to teach." Shall we learn our lesson readily?

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CONTRACTS—A COMPARISON OF "COST PLUS" WITH OTHER FORMS

By Ernest Wilder Clarke, M. Am. Soc. C. E.

To be Presented September 3d, 1919.

Synopsis

1. This paper is presented in order to bring to the attention of the members of the Society the experience with the "cost plus" form of contract on Government construction work during the past two years, and to obtain from them an expression of opinion as to the advisability of a more general use of this form of contract.

2. The paper does not pretend to present any exhaustive arguments, either for or against any form; it is intended simply to form a basis for discussion, with the hope that, as a result of such discussion, some action may be taken that will be of advantage in future construction work.

3. The more or less self-evident objections to the lump-sum and item forms of contracts are mentioned, and some of the advantages which can be obtained from the use of the "cost plus" form are also stated.

The use during the past two years of the "cost plus" form of contract on very large and complicated construction work seems to the

Note.—These papers are issued before the date set for presentation and discussion. Correspondence is invited from those who cannot be present at the meeting, and may be sent by mail to the Secretary. Discussion, either oral or written, will be published in a subsequent number of *Proceedings*, and, when finally closed, the papers, with discussion in full, will be published in *Transactions*.

writer to render the time opportune for a general discussion of the advantages and disadvantages of this type of contract.

In order to bring the matter before the Society, the following résumé of some of the more or less self-evident faults and virtues of the usual contract forms are presented, not with the idea of informing the members of the Society, but to establish a basis for discussion.

The usual methods of paying for work are by lump-sum, by item charges, and by cost plus a percentage. Under the first two methods, the contractor takes the engineers' or architects' specifications and estimates of the quantities, possibly checks the latter by his own computation, guesses at the interpretation which will be placed by the owner's representatives on the terms of the specifications and, from his knowledge of cost of materials and cost of labor, makes up a bid.

In a lump-sum contract the preliminary estimate of quantities is final, as are also the original plans of foundations, details, etc. Any changes must be a matter of settlement between the owner and the contractor. The latter takes all the gamble, and if conditions or quantities turn out more favorably than was anticipated, he wins; otherwise, he loses, or is tempted to decrease the cost to himself by some method which generally means a poorer grade of work than that contemplated in the specifications. If conditions turn out much worse than anticipated by the contractor, he may forfeit whatever bond he put up and leave the owner and bondsman to settle. The owner very often desires to change the plans as the work progresses, either to cheapen the job or to add new features or improvements, and as there is no basis in the contract for payment to the contractor for such changes, a new bargain must be made. Generally, it is almost impossible to let additional work to a new contractor, so the owner is at the mercy of the original one and must submit to whatever terms he offers or forego the changes. The lump-sum contract has all the seeds of misunderstandings, disputes, lawsuits, and poor work, and not even the benefit of a pre-knowledge of ultimate cost, as there is almost invariably a long list of "extras."

In "item" contracts, the award is made on the sum of the products of the units in each item multiplied by the bid per unit. In most engineering work, the preliminary estimate of unit quantities is necessarily approximate—often the owner is unwilling on account of cost or unable for various reasons to make the investigations which

would afford a basis for an exact determination. This is especially true of sub-surface structures, but quantities even in superstructures cannot always be accurately computed in advance. This is one of the great sources of disappointment to the owner in the ultimate cost of work let under this form of contract—of gambling on the part of the contractor and of loss or unfair cost to both.

The contractor and the owner may disagree on the interpretation of the data for the estimate—the contractor backs his judgment by bidding low on items which he thinks are over-estimated and high on those which are under-estimated. His total bid is lower than he would be willing to take the work for if the preliminary estimate of quantities was known to show also the final estimate, but allows a fair or better profit if the final estimate approximates that made by himself. In other words, the owner thinks he is letting the work to cost one sum, and the contractor expects to receive another and larger sum. Badly unbalanced bids are often thrown out, but a skillful bidder does not make his unbalancing so raw as to justify this action. This kind of bidding is not, *per se*, unfair or dishonest, and the ability thus to bid safely may be truly a part of the contractor's equipment, but it results in disappointment to the owner when he finds his final estimate largely in excess of that anticipated. If, on the other hand, such bidding is merely a wild guess or due to optimism on the part of the contractor, it is a gamble pure and simple which, if unsuccessful, results in loss to himself and often to the owner.

Item bids require as a basis a set of definitions. Some items are so self-evident that no confusion can possibly arise as to the meaning of the definition; others shade into other items, and it is hard to define the line of demarcation. Other items are described as containing certain materials in certain proportions, and any variation from these proportions constitutes a new item, more or less expensive. Another item is described as being a certain stock material or machine, and any variation ordered or permitted raises the question of cost to the contractor. The possibility and even probability of argument and variation in cost, due to varied reading of definitions or changes in details of items, could be elaborated almost indefinitely, but enough has been said to illustrate how fruitful of bills for extra cost this part of the specification can be.

The "item" contract is better than the lump-sum in that changes in plan, due to the development of the work or the meeting of unforeseen conditions and variations in unit quantities, can be adjusted under the terms of the original contract, if the items included in that contract can be reasonably construed to apply to the new conditions; but it is still limited by the items which can be so construed and which both the contractor and owner are willing to admit are fair as to cost under these new conditions.

Applying to both these forms are several factors which are taken into account in their bids by all successful contractors and for which all owners pay indirectly. Some of these are the clauses removing responsibility from the owner for the accuracy of the preliminary data; for errors in laying out work; for refusing to accept the action of the owner's inspectors at the time of actual construction and retaining the right of rejection to the final inspection; making the owner's engineer the final interpreter of his own specification and allowing him to supplement his drawings and specification in any way, in order to make the meaning conform to this interpretation. The contractor has to take the gamble that the original data are reasonably accurate, that the work of laying out will be carefully done, or else maintain an engineering organization to check the work—for which duplicate organization the owner will pay—that the engineers will be just, and that the original engineer will remain in charge throughout the life of the work.

Many specifications require tests of material which, if rigidly enforced, would often cause great delay and expense to the contractor or the carrying of a large stock, entailing interest charges, storage space, rehandling, and other expenses. The contractor usually expects that the purchase of material from well-known manufacturers or certificates from them will avoid the enforcement of these clauses, but if he is wise, he considers the possibility that they may be insisted on, and bids accordingly.

In short, the tendency of the entire specifications is to remove responsibility from the owner and his representatives and place it on the contractor; also, all the gamble on weather, foundations, changes in labor and material market, and every other unknown or unknowable factor is carefully unloaded on him.

The contractor accepts all this, but the owner pays. The individual owner may save money, because the gamble went against the contractor on his job, but his neighbor loses, because in the long run the contractor must make money to live. The owner may lose by a contractor being too optimistic, getting a job partly done and then being unable to finish on account of high costs; re-advertising, re-letting, and delays follow, or else the bondsmen finish the work at a loss to themselves, which loss is passed on to other owners.

If a contractor makes an unexpectedly large profit, however, on Job A, he does not reduce his bid on Job B, in consequence, so that it is only the losses that are passed on to other owners and never the gains.

In "cost plus" contracts, the owner accepts all risks, all costs, and receives the benefit of all favorable conditions; each job carries its own load only, without the addition of losses on other jobs and without the percentage added by the contractor to offset possibly unfavorable conditions, ambiguous specifications, or captious owners.

The specifications and plans may be as general or as specific as the owner desires; changes can be made, difficulties met, and advantage taken by the owner of special machines, material, and methods.

The contractor furnishes the plant, organization, and expert knowledge of construction and buying; the owner supervises the work and pays the bills.

In the case of "cost plus" contracts, the contract and not the specifications is the crux of the matter from both the owner's and contractor's viewpoint, but the writing of the contract is more simple than the writing of the specifications. It is necessary first, to define what expenses are to be borne by the contractor, as not part of any one job. These may be head office expenses, salaries of chief officers whose time is spent only in part on the job, traveling expenses, except as agreed on, the contractor's auditors, timekeepers, or material checkers. Second, to define what expenses are to be borne by the owner and are to form the basis for the fee. Such expenses would include the cost of materials purchased through the contractor, the cost of labor of all grades, and the cost or rental of plant. Third, to define what expenses are to be borne by the owner, but which are not to be included in calculating the fee to the contractor. These might be engineering services, inspection, owner's timekeepers and auditors, and the cost of

specified material which the owner elects to purchase and deliver to the contractor.

The approval of the owner would be required for all purchases of material both as to the necessity for the purchase and the price paid. The owner may reserve the right to enter the market with the contractor, purchase any material he can buy cheaper than the contractor, and deduct such cost from the total cost of the work for fee calculation. The owner would have control of the number, grade, and wages of all classes of labor, and, of course, would pay all insurance charges.

The sliding percentage with maximum fee, as used on Government work, could be applied to any contract, large or small.

Contracts could be let on the basis of fee demanded, both percentage and maximum, on the size, adaptability, and condition of the plant controlled by the bidder, and on his experience, reputation, and the size and character of his organization.

It is true that the interest of the owner to keep down the cost, and that of the contractor to receive a large fee, would clash, but that is controlled by the sliding percentage which can be arranged to give an actually larger fee for smaller total cost, and by the maximum fee which is based on the owner's estimate of total cost.

Capable, honest, efficient contractors would fare well under this form of contract; the opposite kind would soon find it impossible to secure work. Engineers of the two classes would meet the same fate as the corresponding contractors. The engineer would no longer be supposed to act as an arbiter when he is paid by one of the parties to the contract to supervise the work of the other and to secure work conforming to specifications and plans which he himself has drawn. The engineer is always biased, and no matter how hard he tries to be fair or how cordial the relation between himself and the contractor, in case of argument, the latter bears the burden of the proof. For this state of affairs the owner pays, and the successful contractor is one who has added enough to his bid, in one way or another, to make up for the losses he suffers due, not to the work itself, but to the specifications. The writer believes that given the same men as owner, engineer, and contractor, a cheaper and better job can be secured by the owner, and, in the long run, more profitable business to the contractor by the "cost plus" contract than by either the lump-sum or item bids. The owner will not be confronted by bills for extras, vexatious claims for adjust-

ments due to different interpretation of the specifications, lawsuits with their attendant cost, and the perpetual chance that, in spite of inspection, poor work will be done by the contractor in order to secure a profit on an underbid item. The contractor will be sure of a reasonable return on his investment in plant, he will not have to pay for special plant of use to him only on that one job, or to carry the burden of the gamble on unknown or unknowable factors.

The gamble belongs to the owner who gains or loses by the location of the site, the season of the year in which the work is done, the state of the market for men, materials, and money, and circumstances other than strictly construction work, which affect the cost of the structure; and when contractors are relieved of this gamble, they can bid closer, they can put their energy and knowledge into efforts to turn out good work, and not be constantly on the watch to cheapen the work for their own benefit—maybe salvation—and the owner's harm.

It will be for the owner and his engineer to say where to cheapen, when to spend, to pay extra prices, if they wish, to speed up work, or secure quick delivery. The job is the owner's; he should handle it and take the profits and the losses.

There can be, of course, great dishonesty under "cost plus" contracts, but, if this occurs, it is the owner's fault in lax supervision of his own forces or from incompetent or dishonest engineers.

It is hoped by this paper to obtain an expression of opinion as to the wisdom of substituting "cost plus" contracts for the other forms. At the present time, municipal work is usually required by law to be let to the lowest bidder, and any violation of the custom, even when the law permits, affords a basis for accusations of graft on the part of the officials responsible, no matter how self-evident the lack of ability of the low bidder may be.

If "cost plus" contracts can wisely be substituted for the other forms, the writer conceives it to be a timely occasion to endeavor to have the laws amended so that municipalities as well as individuals can take advantage of it, and also to draft a standard form of contract sufficiently elastic to be adaptable to all usual work, so that the possible disadvantage may be reduced to a minimum and that dishonest officials may be prevented from discrediting a method which, in the hands of honest men, can certainly produce economical, rapid, and good construction.

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PHYSIOGRAPHY OF WATER-SHEDS AND CHANNELS, AND ANALYSIS OF STREAM ACTION OF SOUTHERN CALIFORNIA RIVERS, WITH REFERENCE TO THE PROBLEMS OF FLOOD CONTROL *

By A. L. Sonderegger, M. Am. Soc. C. E.

To be Presented October 1st, 1919.

Synopsis

Although the basic forces which have brought about destruction by flood flow, and, in consequence, the necessity for flood control in Southern California, are the same as in the Eastern and Northern States, they operate in this country under widely different conditions, with the result that their effect is intensified.

The chief physiographic features of Southern California are the result of block-faulting, the mountains being raised blocks and the valleys sunken blocks. During the process of deformation, materials were eroded from the mountain ranges and transported by water into the depressions or sunken valleys, producing a valley fill made up of gravels, sands, and clay. Apparently, no glacial action has occurred in Southern California.

The sunken valleys present basins of enormous dimensions, embracing areas up to 100 sq. miles, and depths of more than 1 000 ft., and

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Note.—Discussion on this paper is invited, and may be sent by mail to the Secretary. All discussion will be published in a subsequent number of *Proceedings*, and, when finally closed, the paper, with discussion in full, will be published in *Transactions*.

they are the logical storage reservoirs for the flood waters. The velocity of percolation of ground-water is exceedingly low, ranging from ½ mile to 4 miles per annum, the water remaining fresh and potable for indefinite periods. There are some surface storage reservoir sites in the San Jacinto block and in the San Bernardino block, but none of any consequence in the San Gabriel Range.

In Southern California, 75% of the precipitation occurs in the months of December to March, inclusive, and limits flood discharge to those months. In summer the river channels are essentially dry. Flood flow, therefore, may begin to act on a dry river bed, which, subsequently, becomes saturated and is finally exposed to a protracted receding stream flow until it dries up.

The short courses of the rivers from their source, and more particularly from the mouth of their canyons to the sea, traversing an alluvial formation on steep grades, produce below the mouth of the canyons a rapid succession of alluvial and erosional stream activities superimposed upon the general phenomenon of valley construction. The effect is an alternation of stretches where the stream inundates the adjoining country, with sections where it is in a deep cut and undermines the banks.

The most important law affecting stream flow in a natural channel crossing alluvial deposits which readily succumb to erosion, is expressed as follows: The stream has a tendency to charge itself with a burden which is in exact proportion to the power of the water to carry. With constant discharge this power or capacity to carry a burden varies on an average with the fourth power of the mean velocity (Gilbert), or with the fifth power of the bed velocity (Deacon).

The profile of a stream shows a gradually flattening gradient from the source to the sea. (See Fig. 1.)

Every one of the larger streams shows the following characteristic sections: First, a mountain section extending from the source of the stream to the mouth of its canyon. It has the steepest grades and highest velocities, and is the original source of all débris. There are no agricultural or other improvements of any consequence in the mountains, and there is no damage from flood flow.

Second, a débris cone, defined as extending from the mouth of the canyon as far down stream as action is alluvial. (See Fig. 2.) Erosional activity and the transportation of detrital matter

in the mountains being the cause, the formation of the débris cone is the effect. The cone is a fan-shaped area on which the river deposits the larger portion of its débris in traction, and only a little of that in suspension. The stream course is along lines of steepest gradient, issuing from the mouth of the canyon. The danger lies in a shifting at the mouth of the canyon, causing the stream to pursue an entirely new course. The cone offers the most favorable opportunity for the absorption of flood water. The muddy water, during peaks, prevents seepage, and present methods of artificial spreading have not succeeded in reducing the peak flow.

For the San Gabriel River cone it has been proposed to deepen the existing channel and construct embankments of the excavated materials, leaving wide berms. This channel is to be maintained by dredging whenever necessary.

Third, a valley section extending from the foot of the débris cone to the head of the delta, with a channel alternately under erosional and alluvial stream action. The effect of erosion on a channel during the peak flow is a scouring of the bottom, and during a receding flood an undermining of banks, causing the liberation of large quantities of débris and their movement down stream. (See Fig. 3.) The damage is caused by the undermining of the banks. Under alluvial action the stream runs in a shallow channel, depositing a portion of its sediments both in traction and in suspension, and inundating the adjoining country. (See Figs. 4, 5, and 6.) Present methods of improvement are bank protection in erosional channels, and levee construction in alluvial ones, no attempt being made to check erosion of the channel floor.

Fourth, a delta extending from the last erosional channel of the valley section to tide-water. (See Fig. 7.) This is a typical deposit cone, the stream shifting more frequently than on a débris cone. Damage is caused by inundation. Coming to the sea beach there is a pronounced littoral current which tends to deflect estuaries southeastward. (See Fig. 8.) In the larger streams the tidal sloughs and lagoons at their mouths furnish tidal prisms of sufficient magnitude to keep their estuaries open the year round. With the smaller streams ocean breaker action closes the estuaries between flood seasons. The methods of protection contemplated for the Rio Hondo-Los Angeles River are: Levee construction along the course of deepest gradient, and rock jetties to stabilize the estuary.

The magnitude of the flood flow is the basic trouble; but in the absence of suitable storage sites it may be impossible, in many instances, to reduce either the peak or the average flood flow. The local problem resolves itself into one of preventing both erosion and movement of detrital matter.

Theoretically speaking, effective control of floods implies the following ten requirements:

1. That the stream arrive at the mouth of the canyon free from débris in traction.
2. That the stream arrive at the mouth of the canyon delivered of a large percentage of its sediments in suspension.
3. That it be prevented from resuming erosional action on its way down the cone.
4. That means be provided to induce the absorption on the débris cone of the largest possible portion of the flood flow, particularly of the peak load.
5. That erosional stream action be eliminated in the valley section by fixing the channel floor and protecting the banks.
6. That inundation areas in the valley section be defined and controlled.
7. That the stream arrive at the delta delivered of the major portion of its débris, both in traction and in suspension.
8. That inundation areas in the delta be defined and controlled.
9. That the estuary be made secure against closure through ocean wave or current action.
10. In each case exceptional as well as small flood discharge must be taken into consideration, and particularly the cumulative effect of exclusively moderate or small flood flow over a series of years.

General Conditions.

The characteristic physical features of Southern California are a coast line running roughly in a southeast direction and a series of mountain ranges running parallel to the coast line, separated by valleys made up of alluvial fill from these mountains.

The great variation in climatic conditions produced by these mountain ranges, roughly speaking, divides Southern California into three zones, in which the problems of flood control take on different

aspects. The first zone comprises Ventura, Los Angeles, San Bernardino, Riverside, and Orange Counties (with the exception of their desert areas). The ranges attain elevations up to 10 800 ft., and there is a characteristic seasonal rainfall in the valleys, roughly estimated at 16 in. The second zone embraces San Diego County, exclusive of its desert area, with mountain ranges rising to 6 500 ft., and a typical valley rainfall of about 14 in. The third zone includes the desert territory of the Mohave, Coachella, and Imperial Valleys.

Since the question of flood control is more acute in the northern part of Southern California, this paper will be confined chiefly to the first of these zones, and only touch the others; however, it should not be understood that there are no flood-control problems in San Diego County, nor in parts of the desert.

Geology.

The chief physical features of Southern California are the result of block-faulting. (See Plate VIII.) Generally speaking, the crustal movements which ultimately produced the present aspect of the country, raised the mountains, and simultaneously therewith the valleys between the mountain ranges sank. While this process was going on, materials were eroded from the mountain ranges and transported into these depressions, producing the valley fill as it appears to-day, so that the valleys and the coastal plain are not valleys of erosion but of construction. At the end of the Mesozoic period this part of the Pacific Coast was characterized by mountain ranges consisting of metamorphosed sediments, such as schists and gneisses, with intrusions of granite. During the Tertiary period, destructive erosion reduced these ranges to a very material extent, producing on land unstratified deposits of alluvial materials, such as boulders, gravel, sand, and clay, and in the ocean roughly stratified beds of conglomerates and more thinly stratified beds of fine sediments and clay materials, which later gave rise to the formation of sandstones and shales.

At the end of the Tertiary period the country was one of comparatively low relief. The elevation of the coast, as compared with its present elevation, was at least 1 800 ft. lower, and the sea beat against the San Gabriel Mountains or Sierra Madre Range.

At the end of the Tertiary period and the beginning of the Quarternary period, the coast was raised to not less than 700 ft. higher

than it is at present, followed by gradual subsidence to its present elevation.

The mountain ranges rise to nearly 11 000 ft., while the valleys, in general, slope from an elevation of 1 000 ft. more or less down to tide-water. The valleys present a series of sunken basins or reservoirs which, in some instances, are practically completely surrounded by impervious formation, while in others they are open toward tide-water. Many of these basins are of a depth of 1 000 ft. or more, and cover large areas. The San Bernardino River basin, for example, has an area of more than 100 sq. miles and a depth exceeding 1 000 ft., bed-rock being at unknown depth. The basins, therefore, have enormous water storage capacities and become the natural recipients in their porous formation of large volumes of the rainfall running off the steep mountain slopes. Nature has thus provided storage for the flood waters of a magnitude compared with which the contents of the few artificial reservoir sites sink into utter insignificance.

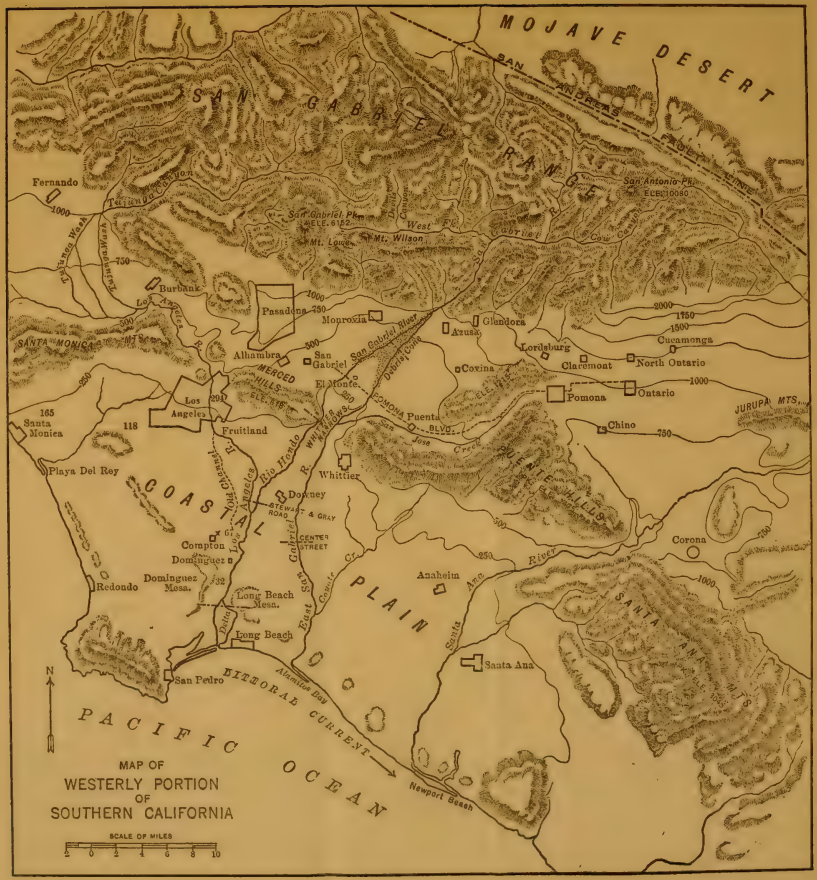
In the northern counties of Southern California the porous beds of these valleys reach depths of 1 000 ft. or more, in fact, in many of them bed-rock has not yet been reached. This applies to the San Gabriel, the San Bernardino, the Pomona and the San Fernando Valleys. In San Diego County a different condition prevails. There the valley fills are much shallower, reaching from 60 to 100 ft., and hence their storage capacity is quite limited.

As previously stated, block-faulting has been the chief agency in forming the present physiographic features. The most noted fault line is that of the San Andreas, which runs from Coachella Valley to San Bernardino Valley, and along the southern escarpment of the San Bernardino block northwest, along the northern margin of the San Gabriel block, toward the Tehachapi. (See Plate VIII.)

The San Bernardino block is tilted to the north, toward the desert, its steepest escarpment being to the south, just north of the City of San Bernardino. The top of this block is comparatively level, with numerous valleys and flats, and quite a number of good reservoir sites. Geologists tell us that these valleys are the remnant of the old topography, as it existed during the Tertiary period before the uplift.

The San Jacinto block is tilted to the west. Its steep escarpment is to the east, toward Coachella Desert, while to the west the slope is less abrupt. The eastern escarpment has a drop of as much as 10 300

PLATE VIII.
PAPERS, AM. SOC. C. E.
AUGUST, 1919.
SONDEREGGER ON
PHYSIOGRAPHY OF WATER-SHEDS
AND CHANNELS.



ft. in a distance of 8 miles, while to the west it slopes from San Jacinto peak (Elevation 10 800) to the City of San Jacinto, about 9 000 ft. in 13 miles. This block also shows remnants of the old topography and has some reservoir sites. It is said that Perris Valley to the west of it, with its cupola-shaped granite buttes, is typical of the Tertiary topography which has undergone but little change.

The San Gabriel Mountains are assumed to be older than the San Bernardino Mountains, and to have been longer subjected to erosion, with the result that the flats have practically disappeared, and there are no reservoir sites of any consequence.

The main ranges consist of eruptive rocks, such as granite and diorites, and metamorphosed rocks, such as schists and gneisses, while the outlying lower ranges are mostly sedimentary. The latter is also the case with the Santa Monica and Ventura Mountains.

Generally speaking, the rocks are much shattered, and only the older granites, as we find them in Perris Valley, and in the Jurupa Mountains near Riverside, are suitable for quarrying.

The fact that the mountain ranges run in series, and parallel to the coast, and the manner in which the outlying ranges were uplifted, has brought about a phenomenon peculiar to Southern California, in that the rivers have cut numerous gaps in the outlying mountain ranges, producing "narrows" which are characteristic of all the larger streams, and are seen in the narrows of the Los Angeles River at Elysian Park; of the San Gabriel River at Whittier; of the Santa Ana River at Colton; and of the Los Angeles and San Gabriel Rivers combined at Dominguez.

Physiography.

There are two factors that put Los Angeles flood-control problems into a class of their own.

The first is of meteorological origin, in that 75% of the seasonal rainfall occurs during the months of December to March, inclusive, resulting in a wet and dry season. Floods occur only during the winter months, while in summer the stream beds are practically dry.

Most of the smaller rivers are dry below the upper portion of their débris cones, except during storms. Even with the largest rivers, the ordinary flow is insignificant as compared with the flood flow or peak load. The action of the stream is, therefore, at the beginning of the

first storm, on a practically dry channel, and this action is widely different from that which occurs after the bed becomes saturated. Again, as a result of the semi-tropical rains on the steep mountain slopes, storm run-off is extremely "flashy", and it may happen that a flood channel that has been dry for six months may be filled to overflow within a few days. Finally, there is the process of the slow drying up of the stream. A receding flow is almost invariably alluvial in its action on the bottom of its channel, but may be under-cutting its banks, or causing saturated banks to cave, so that the condition of the channel at the end of the rainy season is often quite different from that during the flood.

The second factor is the short distance from the mountain peaks to the ocean. The air line from San Antonio peak, the source of the East Fork of the San Gabriel River, with an elevation of 10 080 ft., to the ocean is 44 miles, and the air line from the extreme water-shed of the Santa Ana River, with a maximum elevation of 10 630 ft., to the ocean is 84 miles. The length of the San Gabriel channel from the foot of the San Gabriel Mountains to the ocean, is only about 35 miles, with a drop of 750 ft., or an average of 21 ft. per mile. The stream profiles show the well-known parabolic curve gradually flattening out down stream. (See Fig. 1.) The short run, particularly from the foot of the mountains to the ocean, has produced in the stream channels a succession of sections in which erosional and alluvial action alternate.

Since it is in the very nature of things that the remedies to be applied to a section where stream action is erosional, must be widely different from those where it is alluvial, it becomes fundamental that the natural flood channel be studied, particularly in regard to the nature of stream action.

An erosional stream flows in a more or less rectangular channel of favorable hydraulic properties, sometimes with well-developed berms. It has a tendency to lengthen its course by attacking its banks and producing meanders, thereby flattening its grade and tending to establish equilibrium between its erosional power and the resistance to erosion of the stream bed.

During a flood two distinct erosional actions take place. First, there is scour of the bottom proportionate to the volume of flood flow, and the materials thus set in motion are transported down stream. As

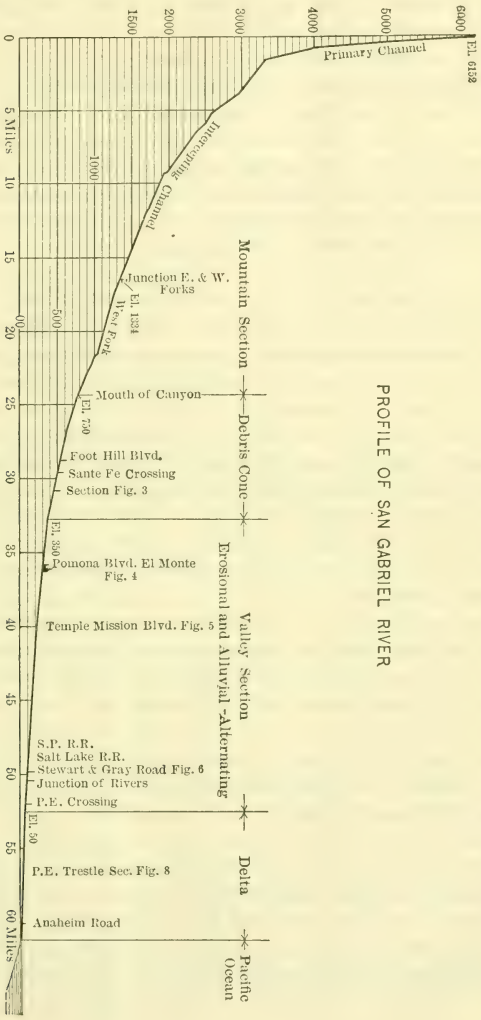

PROFILE OF SAN GABRIEL RIVER
Primary Channel
El. 6132
Intercepting Channel
Junction E. & W. Forks
El. 1334
West Fork
Mouth of Canyon
El. 750
Foot Hill Blvd.
Sante Fe Crossing
Section Fig. 3
El. 390
Pomona Blvd. El Monte
Fig. 4
Temple Mission Blvd. Fig. 5
S.P. R.R.
Salt Lake R.R.
Stewart & Gray Road Fig. 6
Junction of Rivers
P.E. Crossing
El. 50
P.E. Trestle Sec. Fig. 8
Anaheim Road
Mountain Section
Debris Cone
Valley Section
Erosional and Alluvial -Alternating
Delta
Pacific Ocean
0
5 Miles
10
15
20
25
30
35
40
45
50
55
60 Miles
1500
2000
3000
4000
5000
6000
1000
500
400

Fig. 1.

the flood recedes, the bottom gradually rises again, and unless discharge drops off very suddenly, the bottom will be restored to the shape and elevation it had before the flood.*

The second phenomenon is the undermining of the banks, particularly along the outer banks of curves, and this results in a meandering course. At time of full channel the banks become saturated. With recession of the flood the external water pressure is withdrawn, and the banks cave, not only along bends, but also along straight sections. The falling earth is washed away and the damage done along banks increases with a protracted receding flood.

Fundamental Laws Governing Stream Flow.

The most important factor in stream flow is the relation of sediment to cross-section and slope. A stream running through an alluvial valley has a tendency to charge itself with a burden of sediment, which seeks to remain in exact proportion to the power of the water to carry it. It is, therefore, not enough to clarify a stream, but steps must be taken to prevent it from acquiring a new burden.

The scouring capacity of a river is supposed to vary with the square root of the velocity; but it is also very largely dependent on the depth of the flow. This is due to the increased weight. Shallow streams, as a rule, do not produce whirlpools and boils, while depth favors their formation.

Gilbert states that when the discharge is constant so that velocity changes with slope, then the capacity to carry a burden varies on an average with the fourth power of velocity, using the mean velocity instead of the bed velocity (near the bottom and which cannot be accurately measured).

Considering Gilbert's law, it becomes at once evident that even a small change in velocity must immediately affect the volume of burden carried to a considerable degree, and produce either a scouring or a deposit.

The velocity itself is primarily dependent on the slope of the valley, and also on the shape of the channel. It varies in proportion to the square root of both the slope and the hydraulic radius. Width is a factor, a broad channel carrying more débris than a narrow one, but velocities and carrying capacity also increase with increasing depth.

* *Professional Paper No. 86*, U. S. Geological Survey.

If then a stream that is carrying its maximum burden changes its velocity, owing to a change of any of the numerous factors on which the latter depends, there must be a corresponding change of the combination of all these factors, and, in turn, a change in the volume of burden carried.

An important factor is found in the horizontal alignment of a channel, the carrying capacity being affected by turns and their curvature. The convex side of the stream suffers erosion, while the concave side, as a rule, shows the formation of a bank.

Tributaries produce a steeper slope after the point of confluence. An affluent brings in a quantity of material which the main stream, having its own burden to carry, cannot entirely absorb under the same grade. As a result, deposits may occur below the point of junction, until the river-bed is raised and the velocity increased to such an extent as to take care of all sediment. Upon last analysis it is found that the ruling element is that of the slope.

Careful study of the old river channels will often disclose the very important fact that, in almost every one of the differing sections, stretches may be found where the river is in a state of equilibrium, neither attacking banks, overflowing, nor depositing, and scouring its bottom only during extreme high floods. Particular attention should be paid to such portions of the river-bed, and all its properties ascertained, such as geological formation, character of the banks, slope of banks, their vegetation, grade of the river-bed, its cross-section, horizontal alignment, and the character of the débris. In the writer's opinion, these properties must form the basis for the solution of the problem at hand. Nature often will indicate what type of channel will best serve the purpose.

In the discussion which follows reference is made by way of example to the San Gabriel River as being a characteristic normal stream, and one of the most important in Southern California. It has a water-shed above the mouth of its canyon of 222 sq. miles, and a flood peak exceeding 30 000 sec-ft.

Every one of the larger rivers exhibits at least the following characteristics:

1. A mountain section, in which stream action is erosional, this section being defined as extending from the source of the stream to the mouth of the canyon.

2. A débris cone, extending from the mouth of the canyon as far as river action is alluvial.

3. A valley section, beginning at the foot of the débris cone, where river action becomes erosional. This district, as far as the tidal rivers are concerned, may be defined as extending to the delta, while with intercepting streams it would reach to the point of junction with the main stream. River action in the valley section, as a rule, starts with erosion. A few miles below, it may turn into alluvial action, then back to erosional, and again to alluvial. The alternation is apparently more frequent in the smaller than in the larger streams.

4. A delta section, which is the last alluvial sector, and terminates at tide-water.

Description of Characteristics of Individual Sections.

The Mountain Section.—The mountain ranges of Southern California rise from 1 000 to 10 000 ft. above sea level. The foot-hill region along the line where canyons debouch into the valleys, is about at an elevation of 1 000 ft. By far the greatest portion of the mountainous area is below Elevation 6 000. As far as the San Gabriel, San Bernardino, and San Jacinto blocks are concerned, the formation is granitic and metamorphic, including gneisses and schists. The outlying hills are either shale or old alluvial formation. An exception to this rule is found in the Santa Monica and Ventura Mountains, which are sedimentary.

As a rule the mountains are covered either with dense brush or timber. The lower timber line is at 5 000 ft. Invariably, it is found that slopes dipping to the north have a better forest cover than those more directly exposed to the rays of the sun. A shady slope shows a thicker crust of earth than a sunny one. The absence of a brush cover exposes the slope to washing, leaving often only a thin crust of earth overlying bed-rock.

The grades of the mountain sides are very steep, slopes of 2 000 ft. per mile being common; consequently, the stream beds of the side canyons, which may be called primary creeks, are equally steep. These primary streams generally flow on bed-rock, often along fault lines, and in narrow gorges. The action of the floods keeps these gorges well scoured. It is believed that the quantity of débris transported by individual primary canyons is comparatively small. The

writer has, however, no specific data to offer in support of this opinion, and reliable information on the subject is much needed.

The steep primary canyons, as a rule, discharge into a collecting channel of much flatter grade. Always a short distance below the point of a junction is to be found a deposit of débris, which is really the débris cone of the primary channel. Since primary channels, as a rule, follow in rapid succession, it is found that the intercepting channel presents a comparatively wide bed of deposits of large boulders, gravel, and sand along its entire length.

In order to make this description more tangible, reference is made to the West Fork of the San Gabriel River. This fork issues from San Gabriel peak, with an elevation of 6 152 ft., as a primary creek for about 1½ miles, and drops to an elevation of 3 500 ft., where it assumes the rôle of an intercepting channel.

The general course of the West Fork is easterly, intercepting numerous primary channels, and some minor intercepting channels from both the north and south sides. The length of the intercepting channel is about 14 miles, and the drop 2 200 ft., to the junction with the East Fork of the San Gabriel River, at an elevation of 1 360 ft. The primary tributaries intercepted by the West Fork have an average grade of 2 000 ft. to the mile, while the intercepting channel itself averages 160 ft. to the mile. From the junction of the West and East Forks to the mouth of the canyon at Azusa, the distance is 9 miles, and the drop about 600 ft. Although it is quite clear that the primary channels are under the constant action of erosive forces, it would appear that the secondary or intercepting channel remains more or less in a state of equilibrium. During each flood, primary channels will bring certain quantities of débris into the valley, and these, in turn, are carried on during the flood, with the result that, over a period of years, these intercepting channels remain about the same, showing neither permanent cutting nor alluvial action. This fact should be remembered in the discussion of the effect of check dams; because should the transportation of the coarse débris from a primary to an intercepting channel be stopped, the stream, when reaching the latter, would have a capacity to load itself with a new burden, and would begin erosion until a flatter grade had been formed and a new state of equilibrium established.

Attention is called to another fact—the comparatively short length and low drop of an intercepting channel, as compared with the sum of the lengths and drops of the primary channels which feed it. The difference is particularly striking in the drop, which may be only one-twentieth of that of the primary channels. These facts should receive attention in considering the feasibility of constructing check dams over an entire water-shed. If it is simply desired to arrest the transportation of débris, it might be done at less expense in the intercepting channel than in its primary tributaries.

The canyons, while all steep, do not all have the characteristics of highly erosional channels. Canyons filled with large deposits of alluvial materials, particularly of old alluvium, are frequent. These deposits are well consolidated, are covered with brush and timber, and apparently absorb a large proportion of the rainfall, even during periods of heavy freshets. They invariably produce, comparatively speaking, a prolific summer flow. Their stream beds indicate that flood discharge occurs in a moderate volume, as compared with canyons which may be immediately adjoining, and which have all the markings of wild storm channels. Apparently, in these canyons, Nature has produced what man is trying to accomplish, and for this reason they should be studied in solving problems of river improvement.

Summarizing the characteristics of the mountain section, it may be stated that it has the steepest grades, the most rapid run-off, the highest velocities, and last, but not least, it is the original source of all débris.

As the disintegration of rocks and the formation of débris cannot be checked, there remains the prevention of its transportation into the valley below.

The Débris Cone.—Below the mouth of a canyon, grades become flatter, and the coarser débris brought down from the mountain section is deposited in fan-shaped areas, commonly called débris cones, and here defined as extending from the mouth of the canyon as far down stream as action is alluvial. Erosional action and the transportation of detrital matter in the mountain section may be defined, therefore, as the "cause", and the formation of the débris cone as the "effect."

The channel on a débris cone is, as a rule, a pronounced cut, not always entirely straight, but not materially deviating from the line

of steepest grade. A slight shifting at the apex, however, may cause the stream to follow an entirely new path, although still along a line of steepest gradient. It is a fact that the San Gabriel River at Azusa might find a channel either side of its present course. In either case, it would invade a large area now in a high state of cultivation.

In the very nature of things, it is difficult, if not impossible, to maintain a stream on the débris cone permanently in the same channel. Fig. 2, compiled from data contained in the Los Angeles County Flood Control Report of January 2d, 1917, represents a cross-section through the débris cone 4 miles below Azusa.

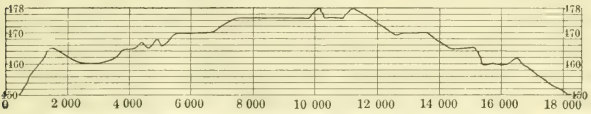


FIG. 2.

The cone covers a roughly triangular area, with its apex at the mouth of the canyon at Azusa at an elevation of 750 ft., and with a base about 3 miles wide at a distance of 6 miles below Azusa. The débris at the apex varies from large boulders, weighing several tons, to coarse gravels, while at the base the largest boulders may average 200 lb. At the base (Elevation 350), the river divides into two channels, the Rio Hondo, flowing southwest, and the East San Gabriel, flowing south. At present, by far the largest portion of a flood finds its way into the Rio Hondo.

On the débris cone much seepage occurs into the underlying gravel beds, particularly during heavy storms. The percentage of seepage increases as the débris becomes smaller and more uniform in size. The writer's experience has shown that an aggregate, such as is generally used for concreting, presents an excellent seepage bed, while large boulders and coarse gravel reduce the percentage of absorbing voids. Still better results are obtained with fine sands, but they are not always to be found on the cone. The water-plane under a débris cone is, as a rule, at considerable depth, from 100 to 200 ft. or more below the surface; so that storage basins of large capacity are often available.

During the peak of floods the quantity of silt in suspension is large, and such muddy water is not absorbed. It has become the practice in artificial spreading works not to divert any water during the

first day or two of a flood, so as to eliminate the muddy water which would silt up the pores of the gravel beds. If, therefore, artificial absorption be practiced to reduce a peak load, the first requisite will be that the quantity of silt in suspension be very materially reduced. The greatest difficulty so far encountered with unimproved streams, however, is the instability of the channel on the cone and the danger of causing diversions, for which the manipulator would be responsible.

The action of a heavy flood in most channels is to tear up the stream bed and produce temporary scouring. Subsequently, during the receding of the river, the scoured bed is refilled. Since streams always carry some silt, the effect of a receding stream is to silt up the pores in the gravel of a débris cone, making it almost water-tight. A great deal depends on the formation which the stream traverses in its upper course. Wherever there are lime deposits or clay, the sealing process is almost perfect. The best example of such silting is probably the Whitewater River near Banning, which most of the time has a milky appearance from the silt it carries, which silt is extremely effective in sealing the pores after the winter floods.

It is essential, if the natural seepage be maintained, that floods should occur, which will tear up the river-bed and re-open the pores. The tearing-up process is the most important function of a flood and furthers natural absorption.

The changes in the course of a stream on its débris cone presents a criterion from which conclusions might be drawn as to the quantity of débris produced in the mountain section. No information has come to the writer's knowledge that either the San Gabriel River or the Santa Ana River has materially changed its course during the last 60 years.

The improvement contemplated by the Los Angeles County Flood Control District for the San Gabriel River cone is described in its Report of 1917, page 29, as follows:

"The work required is the excavation of a channel 400 ft. wide and 4 ft. deep to form a minor or interior channel. The material from this excavated channel is to be placed in levees upon either side of the channel, and at a distance varying from 600 ft. to ½ mile, as shown upon the Plate. This boulder material is to form levees which will be 12 ft. wide on top, the slope on the water side will be 3 horizontal to 1 vertical, and upon the back or land side will be 1½

horizontal to 1 vertical; the elevation of the tops of these levees to be 18 ft. above the bottom of the minor or interior channel. This minor channel will provide for the carrying of ordinary floods, say, up to 20 000 sec-ft., while when the great floods of 40 000 or 50 000 cu. ft. per sec. come, the entire area between levees amounting to 2 500 acres will be flooded, thereby providing a large spreading ground. This design of a minor and major channel will have a tendency to hold the principal thread of the main current near the center of the minor or deeper channel, and thereby reduce the velocities near the levees, on the whole having a tendency to arrest velocity and precipitate the detritus, and to cause as much of the flow as possible to percolate and reach the artesian water through the coarse materials at the head of the valley. * * *

"* * * It should now be distinctly understood that the plan of the channel here outlined, and, for that matter, any other channel in a detrital country, will require examination and correction after every flood. Great floods coming out of the San Gabriel canyon always, when at peak, bring great loads of detrital matter which are dropped by a very sensitive natural law as the velocity or carrying power of the stream weakens with every slight reduction of the gradient, and a heavy part may be dropped by one storm a short distance down this very large channel, while the next flood wave being larger or smaller, may drop its load farther down, or higher up. This condition must be watched with a vigilant eye and removed so thoroughly after each storm as to bring both the minor or interior channel and the larger or major channel to a carrying capacity. If this maintenance is neglected, disaster will follow."

Effective control of floods on the débris cone requires, first, that the stream arrive at the mouth of the canyon delivered of its rolling débris; second, that the stream be prevented from resuming erosive action on its way down the cone; third, that the stream arrive at the mouth of the canyon delivered of the larger portion of its sediments in suspension; and fourth, that means be provided to induce the seepage into the ground of a large percentage of the flood flow, particularly of the peak load.

The Valley Section.—A stream, having delivered itself on the débris cone of its burden of coarse detritus, such as boulders, large gravel, and coarse sand, has a scouring-capacity from the point where it leaves the cone, and, therefore, will produce a stream-bed in cut. Proceeding down stream the cut gradually becomes shallower and a

deposit of sediment takes place. With most rivers there occurs in the valley section a succession of erosional and alluvial stream activity.

A channel in cut has a more or less rectangular cross-section, sometimes with well-developed berms. The formation in the valley districts is an alluvium, consisting of gravelly or sandy loam, which becomes finer with lower elevations, constituting river banks that readily succumb to scouring action under high velocities. The floor of a channel consists of different materials than the banks. The high flood velocities of a cutting stream have a distinct scouring effect on the bottom, and the materials forming it are, during the flood flow, in motion to great depth. A large quantity of sand and silt is, therefore, liberated and set in motion, which ultimately will be laid down where grades become flatter and velocities lower. This débris in traction undergoes a natural process of assortment, the heavier sinking while the lighter remains near the top, with the silt floating off in suspension. A test hole in a river-bed would show a fairly well assorted deposit, ranging from sand on the surface to gravel and small boulders at greater depth. As the flood recedes the bed is refilled, and over a series of years its profile and depth remain about the same.

From observations on the Santa Ana River by Mr. G. O. Newman in 1892, it was concluded that the deposits forming the bed at the point of observation were in motion during flood to a depth of at least 15 ft.

The volume of débris liberated and moved on account of erosion of the channel floor is many times greater than that produced by washing of banks. Scour of the channel floor is at its height during the peak flow, while undermining of banks is, as a rule, more pronounced during a protracted receding flood, as previously mentioned. The damage in an erosional section is caused by undermining of the banks, not by overflow.

The effect of the erosional action and the loading of a river becomes manifest proceeding down stream under a flattening gradient. The channel becomes gradually shallower and the stream drops its débris and eventually overflows its banks. This process is sometimes so pronounced as to produce a secondary débris cone with its characteristic steepest gradients along lines running through its apex. An example is to be found in the Los Angeles River which, some years ago, had its course from Fruitland south, passing between Bell

Station and Huntington Park, while to-day it flows from the apex of its secondary débris cone at Fruitland in a southeast direction, passing east of Bell Station.

As a rule there is a pronounced small channel in these alluvial sectors.

Fig. 5 is a cross-section of the Rio Hondo at the Stewart and Gray Road, just below Downey, where the river begins to overflow. The

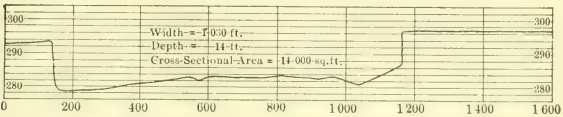


Fig. 3.

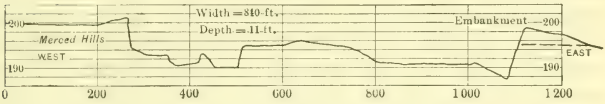


Fig. 4.

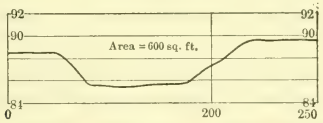


Fig. 5.

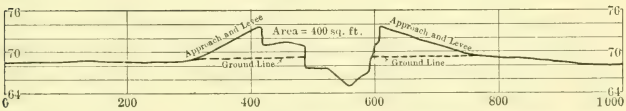


Fig. 6.

cross-sectional area is 600 sq. ft. as compared with 14 000 sq. ft. at Pomona Boulevard, as shown on Fig. 3. (See also Fig. 6.)

Below an alluvial section there invariably follows an erosional one, and *vice versa,* until the stream is absorbed by a larger one or enters its delta. For the Rio Hondo the last erosional sector is located between Downey and Dominguez, below the junction with the Los Angeles River. The slower velocities in an alluvial or inundated section are favorable for the absorption of flood-water, provided the

water is reasonably clear and the water-plane at some depth below the surface.

It would appear rational to assume that after a long period of years a stream would change its activity in a locality from alluvial to erosional, and *vice versa.*

There is a wide difference in the character and volume of flood flow from forested or brush-covered mountainous water-sheds, as compared with urban or interurban drainage areas. Drainage channels issuing from the latter have no débris cone and move a large quantity of detrital matter into the valley section. The effect of this is noticeable particularly during a series of years of moderate or deficient rainfall. Years may pass without the heavy rains which produce a moderate flood run-off in the mountains, while occasional short but intense showers may cause a flashy run-off from city and interurban streets, of sufficient force to carry a considerable load of sediment into the smaller natural drainage channels. The volume of flood flow may be sufficient to reach a main drainage artery; being without support from the mountains, it may not reach tide-water, but slowly seeps away. It also occurs that a flood flow may be of such short duration that it will not pass beyond a minor branch channel.

However, in each case, there will be a deposit of detrital matter, at least along portions of secondary channels, and sometimes over portions of a main channel. The cumulative effect over a period of years of such stream activity is a partial filling up of the affected river-beds, with the result that they are not in shape to take care of a sudden exceptional flood. The remedy commonly resorted to is to provide a compound cross-section with a small central channel and wide berms. In order to be effective, however, this type of construction must be carried clear to the sea.

The present methods of improvement in the valley section are bank protection by pile and wire entanglement for erosional river-beds, and levees for alluvial ones. No attempt has been made with larger streams to check bottom erosion by the introduction of fixed sills.

A peculiar feature of the valley zones are the "narrows" which form what might be called fixed points in the valley course of a river, where the river must pass regardless of what action might take place in its course above or below. The effect of narrows is mani-

fested not only on the surface streams, but also on the underflow, in that the contraction of the valley brings the underflow to the surface, and produces artesian or rising streams and artesian flow in cased wells.

Reviewing the characteristics of the valley section, it is found that the flood channels appear as alternation of erosional channels and more or less pronounced alluvial cones. The stream reaches the valley section with a capacity to increase its burden, and invariably leaves it with a full load. Damage is caused by the washing of banks in erosional channels, and by inundation in alluvial ones.

River control in the valley section requires the prevention of erosion and the transportation of detrital matter, alternating with protection from inundation, with the ultimate purpose of delivering at the delta a stream free from débris in traction, and clear of the major portion of its sediments in suspension. Improvements on the débris cone and in the mountain section above, unless resulting in a reduction of volume of stream flow, are of no material beneficial effect in the valley section. In fact, an attempt to clarify the stream and to deliver clear water into the valley section would be positively injurious, unless accompanied by the introduction of flatter gradients.

Exceptional as well as small flood discharge must be taken into consideration, and particularly the cumulative effect of exclusively moderate or small flood flow over a series of years.

The Delta Section.—In the delta section, grades continue to flatten down to such an extent that the action of the river becomes alluvial, building up a cone of sand and silt. As a rule, the stream channel is quite shallow and of small carrying capacity, so that even ordinary floods produce inundations. Shifting of the channel occurs more frequently than on the débris cone. A single flood may produce deposits over large areas, of 1 ft. or more, as has occurred near Long Beach during the floods of the Rio Hondo-Los Angeles River.

For this river the delta starts at Dominguez at an elevation of 50 ft., about 10 miles from tide-water, with a grade of 7 ft. to the mile, while in the vicinity of tide-water it falls to 2 ft. per mile. Fig. 7 gives a cross-section of the delta between the Dominguez and Long Beach Mesas. It will be noticed that the country is flat and that there is no pronounced channel of large capacity. This area has been inundated during heavy floods over its entire width.

If natural conditions, such as grades, volume of flow, and silt, would permit a solution of the problem in the delta district, stretches would be found where the stream-bed is in a state of stable equilibrium, and such stretches would indicate the grades and character of channel required. In a typical delta, the writer has nowhere found such conditions.

At the estuaries of streams are found almost invariably large tidal flats, often with a considerable number of tidal channels and lagoons. The banks of the tide flats are about at the elevation of high tide, between 5 and 6 ft. above mean low water. Where the area occupied by the tidal channels and lagoons is of considerable extent, so as to produce a tidal prism of some magnitude, the estuary is open all the year round, regardless of the fact that the rivers dry up in summer, as, for example, at Alamitos Bay, Newport Beach, Playa del Rey, and Long Beach. In many streams, however, the tidal prism is not sufficiently large, and breaker action closes the estuary soon after

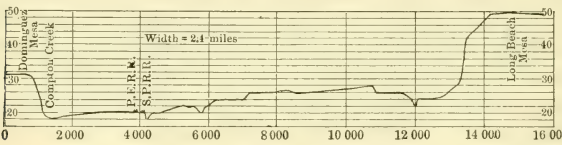


FIG. 7.

the winter floods, to remain in this condition until the next flood. These conditions are observed at Santa Barbara, at Hueneme, and in many estuaries of the minor rivers.

The average rise of tide in Southern California is between 5 and 6 ft., the maximum being between 8 and 9 ft.

There is a strong littoral current along the coast of Southern California, running in a southeast direction. Its effect has been to shift the mouths of the streams down coast, there being a constant scouring action on the south side of the estuary. This has come to the writer's notice particularly at Long Beach. Some of the older coast survey maps which show the estuary at Long Beach, show the outlet about ¼ mile west of the present lift-bridge of the Salt Lake Railroad. When in the early Nineties, the Los Angeles Terminal Railway, now the Salt Lake Railroad, built its trestle across the estuary, it was found difficult to prevent the scouring of the eastern

embankment, and many carloads of boulders and scrap iron were dumped to consolidate the east bank at the crossing. The bridge was about 500 ft. inland from the high tide line. However, the littoral current was strong enough to produce a deflection along the beach, as shown in Fig. 8.

The deflection of an estuary continues until checked by a resisting formation, like the shale hills of Playa del Rey, or the clay mesas of Seal Beach, Huntington Beach, and Manhattan Beach.

If it happens that a flood is great enough to cut through the sand spit at its land end, a direct outlet into the ocean will be established

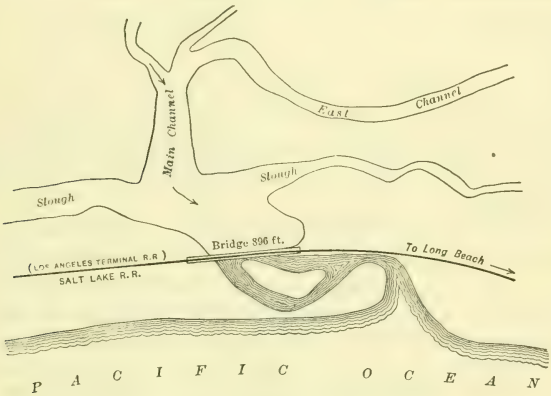


FIG. 8.

along the lines of steepest grade, as occurred with the Santa Ana River during the flood of 1916, when it abandoned Newport Beach lagoon and estuary, and cut a direct channel to the beach about 2 miles west of the estuary.

After such a direct outlet is cut, the littoral current immediately resumes its action tending to shift the estuary again to the south. Eventually, the effect will be a gradual obliteration of the old sand-spit and the formation of a new one in the wake of the shifting estuary.

An example of a river the delta of which begins only at tide-water, is the Santa Clara in Ventura County. The peculiarity of this river is

that from Santa Paula to tide-water, or a distance of 16 miles, the grade changes very slightly, namely, from 16.7 ft. to 13.5 ft. per mile. As a consequence, the river is in cut practically to the beach. At the State Highway bridge near El Rio, about half way between Ventura and Oxnard, and 4½ miles from tide-water, the river runs still in a well pronounced cut, at an elevation of 62 ft. above sea level. Charles W. Petit, Assoc. M. Am. Soc. C. E., County Engineer of Ventura County, has stated that the elevation of the river bottom at the bridge did not change at all between 1896 and 1912. The problem on the lower Santa Clara River is, therefore, clearly one of bank protection.

Summarizing conditions in the delta section, it may be stated that they are those of a river running on a flattening grade, and therefore unable to carry its load of sediment. The result is the building up of a delta, or sedimental cone, over which the stream spreads out and shifts its course with every large flood. It is not possible to improve the general condition of grades. Some relief may be gained by concentrating the flow between levees and giving the channel the shortest route possible to tide-water, as is proposed for the Rio Hondo-Los Angeles River.

However, the basic trouble is the sediment, and this can only be eliminated by preventing its accumulation in the preceding erosional section. A stream arriving at the head of its delta in a more or less clarified state, would have a capacity to erode and cut a deeper channel, even on the flattening gradient of the delta formation, and it is conceivable that during moderate floods it might be able to take care of itself without further improvement. For extraordinary floods, the inundation area should be defined by levees and its use for residential or industrial purposes prevented.

The littoral current which, in this section of the coast, tends to deflect an estuary in a southeast direction, will exercise a marked influence on the land water flood problems.

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PAPERS AND DISCUSSIONS

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COMPREHENSIVE PLOTTING OF WATER TURBINE CHARACTERISTICS*

By Karl R. Kennison, Assoc. M. Am. Soc. C. E.

Synopsis.

This paper presents a chart for the comprehensive plotting of water turbine characteristics. The use of this chart would enable the manufacturer of a water-wheel to show simply and clearly the performance of his turbine under any and all conditions. It would enable the purchaser intelligently to weigh the merits of different turbines and their compliance with specified requirements.

The arrangement of the paper is as follows:

1. The Need of Comprehensive Plotting.
2. Specific Characteristics of Water Turbines.
3. Description of the Chart.
4. Typical Water Turbines of American Manufacturers.
5. Method of Using the Chart.

1. The Need of Comprehensive Plotting.

The test performance of a water turbine is most commonly represented by a series of curves, one for each gate-opening used in the test. Two, or sometimes three, sets of such curves are usually presented. For all these curves the horizontal scale is laid off in terms of the speed under a given head. For one set the vertical scale is efficiency, for the other, it is power output, and sometimes a third set is added, showing the discharge.

* This paper will not be presented for discussion at any meeting of the Society, but written communications on the subject are invited for subsequent publication in *Proceedings*, and with the paper in *Transactions*.

Such curves do not give a sufficiently clear indication of the results that would be obtained at any other gate-opening not included in the tests. An engineer, if he has made a study of the performance of water turbines—but not unless he has made such a study—can interpret these curves and fit them to any desired conditions of head, speed, discharge, etc. Most engineers, however, are busy men, and after learning that the specific speed of a water turbine is that speed at which it would run under a 1-ft. head, if they could imagine it reduced in size until it developed only 1 h.p., they give it up as a bad job.

The following diagrammatic method of showing the performance of a water turbine has proven so simple and convenient to the writer, that he presents it for the consideration of hydraulic engineers and turbine manufacturers.

2. Specific Characteristics of Water Turbines.

We are concerned with seven variable quantities. It is, of course, the large number of variables which so complicates the problem. For convenience, let us refer to them by the following letters:

D = rated diameter, in inches.
H = head, in feet.
N = speed, in revolutions per minute.
P = power output, in horse-power.
Q = discharge, in cubic feet per second.
Gate-opening.
Efficiency.

For various reasons large units may show a slightly increased efficiency over small models under all conditions of operation, but it is aside from the purpose of this paper to discuss the extent of such an increase, and no further account will be taken of it. No attempt will be made to discuss the design of turbines, but certain characteristics will be stated as concisely as possible.

It is characteristic of water turbines that when any given design or type is varied in diameter, all the dimensions, of course, being kept in proportion, the efficiency will remain the same, at the same gate-opening, if N is varied directly as $\sqrt{H}$ and inversely as D; and the resulting P will vary directly as $H^{\frac{3}{2}}$ and as D^2, and Q will vary directly as $\sqrt{H}$ and as D^2.

$\frac{D \times H^{\frac{1}{4}}}{Q^{\frac{1}{2}}}$ = Specific Diameter (Corresponding to Given Head and Discharge).

$\frac{H \times 10^3}{N^2 \times D^2}$ = Specific Head (Corresponding to Given Speed and Diameter).

$\frac{N \times Q^{\frac{1}{2}}}{H^{\frac{3}{4}} \times 10^2}$ = Specific R.P.M. (Corresponding to Given Head and Discharge).
(Numerically Equal to "Specific Speed" at 85% Eff.).

$\frac{Q \times 10^6}{N \times D^3}$ = Specific Discharge (Corresponding to Given Speed and Diameter).

Hence, the following are twelve simultaneous constants:

Efficiency,	Gate-Opening,	$\frac{N\ D}{\sqrt{H}}$,
$\frac{P}{D^2\ H^{\frac{3}{2}}}$,	$\frac{Q}{D^2\ \sqrt{H}}$,	$\frac{P}{D^5\ N^3}$,
$\frac{Q}{N\ D^3}$,	$\frac{P\ D^4}{Q^3}$,	$\frac{N\sqrt{Q}}{H^{\frac{3}{4}}}$,
$\frac{P}{Q\ H}$,	$\frac{P^3}{N^4\ Q^5}$,	$\frac{N\sqrt{P}}{H^{\frac{5}{4}}}$,

Of these, the last constant is the one commonly known as the "specific speed." It is that constant which expresses the relation between speed, head, and power.

Of the seven variables referred to, only six are independent variables, since power output and discharge are inter-related through the efficiency. Simplification demands that either P or Q be eliminated from consideration. The writer is aware that he is departing from present practice in eliminating power output and retaining discharge capacity.

Performance curves are usually drawn to show the horse-power output, and with good reason, as the turbine user is looking for results, and the power output is certainly the result in view. However, the problem before the engineer usually involves a given head and a given discharge—to find the turbine which will give the greatest efficiency. The head and discharge are the fundamental quantities with which we have to deal.

For example, the so-called specific speed of a turbine, already referred to, is the criterion by which we judge whether it is of the right type to do its best at suitable speed under relatively low head and high discharge, or *vice versa*. Two turbines may be of the same type in this respect, and yet one may be much more efficient. Hence, the writer claims that the specific speed should properly show the relation between speed, head, and discharge, instead of between speed, head, and power.

Therefore, the type characteristics of a water turbine may be obtained from the previous list of simultaneous constants by omitting those involving the power output. The form in which they are ex-

pressed subsequently has been chosen for convenience of mathematical expression. On account of taking advantage of a fortunate mathematical coincidence, what the writer proposes to call "specific r. p. m.", or the relation between speed, head, and discharge, is numerically equal to the "specific speed" currently expressed as the relation between speed, head, and power, at the efficiency attained by wheels of good design, namely, 88 per cent. Hence, the two terms are practically interchangeable in any general reference to approximate values.

The characteristics are as follows:

$$\text{Specific head} = \frac{H \times 10^7}{N^2 D^2}$$

$$\text{Specific discharge} = \frac{Q \times 10^6}{N D^3}$$

$$\text{Specific diameter} = \frac{D H^{\frac{1}{4}}}{Q^{\frac{1}{2}}}$$

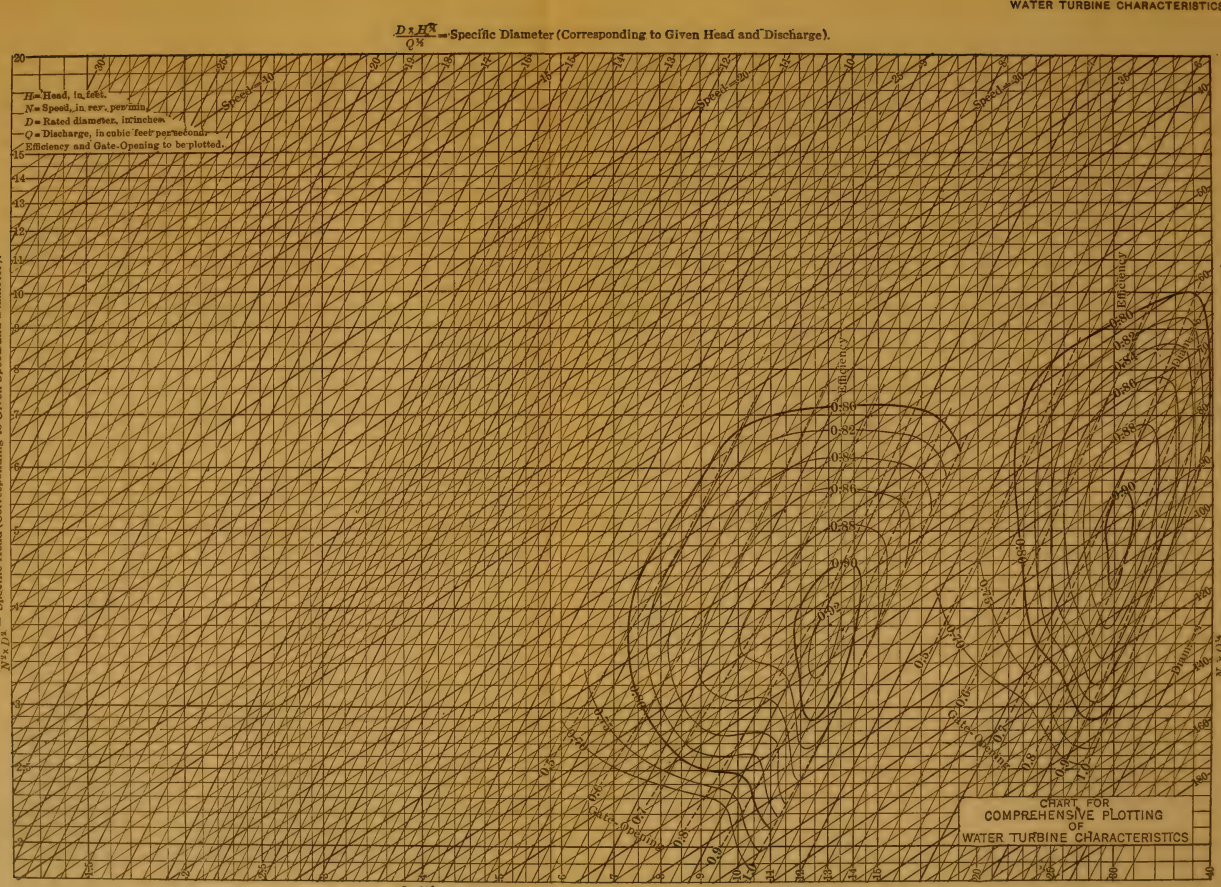
$$\text{Specific r. p. m.} = \frac{N Q^{\frac{1}{2}}}{H^{\frac{5}{4}} \times 10^{\frac{1}{2}}}$$

3. Description of the Chart.

The chart is simply a means of plotting efficiency and gate-opening in terms of the four fundamental type characteristics listed previously.

The plotting of test data of any turbine on this chart tells the complete story of the performance of this type or design of turbine, regardless of actual head, discharge, diameter, or speed of the turbine in question; and the plotted result can then be used to show the expected performance under any other desired head, discharge, diameter, or speed.

As the co-ordinate scales for plotting are fixed and can easily cover the entire range of turbine design, the difference between one type of turbine and another is shown at once by the relative location on the chart. For example, nearness to the lower right-hand portion of the chart means high speed and small diameter. Moreover, of several types which plot equally near the lower right-hand portion, the lowest is relatively the fastest and largest and the farthest to the right relatively the slowest and smallest.


$\frac{D \times H^{\frac{1}{2}}}{Q^{\frac{1}{2}}}$ = Specific Diameter (Corresponding to Given Head and Discharge).
H = Head, in feet.
N = Speed, in rev. per min.
D = Rated diameter, in inches.
Q = Discharge, in cubic feet per second.
Efficiency and Gate-Opening to be plotted.
$\frac{H \times 10^7}{N^2 \times D^4}$ = Specific Head (Corresponding to Given Speed and Diameter).
$\frac{N \times Q^{\frac{1}{2}}}{H^{\frac{3}{4}} \times 10^4}$ = Specific R.P.M. (Corresponding to Given Head and Discharge)
(Numerically Equal to "Specific Speed" at 88% Eff.).
$\frac{Q \times 10^6}{N \times D^3}$ = Specific Discharge (Corresponding to Given Speed and Diameter).
Efficiency
Speed
CHART FOR
COMPREHENSIVE PLOTTING
OF
WATER TURBINE CHARACTERISTICS

The vertical and horizontal scales represent the two most important variables with which we have to deal, namely, head and discharge, respectively, so that when the characteristic curves are plotted for any type of turbine, the available range of head and discharge stands out very clearly.

On account of the logarithmic scale of the co-ordinates, the range of operation of any two types may be compared regardless of their location on the chart. For example, the vertical distance enclosed by the 80% efficiency line is the measure of the percentage variation in head in which this efficiency is equalled or exceeded, and, similarly, the horizontal distance is a measure of the percentage variation in discharge. In this respect, a low-speed turbine at the left of the diagram is directly comparable with a high-speed turbine at its right.

4. Typical Water Turbines of American Manufacturers.

Only inward and downward flow turbines are represented. Plate IX shows the characteristic curves of four turbines made by one American manufacturer, covering a wide range of conditions. The specific speeds, at most efficient operation, are, as shown by the chart, approximately 25, 47, 61, and 90. A glance shows that high specific speed is evidently obtained at a sacrifice in efficient range of discharge capacity.

Plate X shows the characteristic curves of two turbines made by another American manufacturer, the specific speeds being approximately 77 and 96. The first turbine is highly efficient. It plots low down on the chart, indicating a relatively large diameter. It should be borne in mind that the rated diameter is a more or less arbitrary dimension and that it depends on the amount the runner vanes are cut away. However, the point of measurement of diameter being once determined, the chart gives as exact relations in the case of the diameter as of any other variable. The second turbine is remarkable for its combination of high specific speed and comparatively large range of efficient operation.

A great deal of information as to the performance of American water turbines, of the inward and downward flow type, is condensed in Plates IX and X.

5. Method of Using the Chart.

Plate XI shows at the right a third American manufacturer's turbine with a specific speed of about 91. The method of using the chart is described very briefly, as follows:

Suppose this type of turbine is proposed for the development of an available normal discharge of 240 cu. ft. per sec. per wheel, under a normal head of 30 ft., subject to variation from, say, 24 to 32 ft., often enough to require high efficiency at these heads.

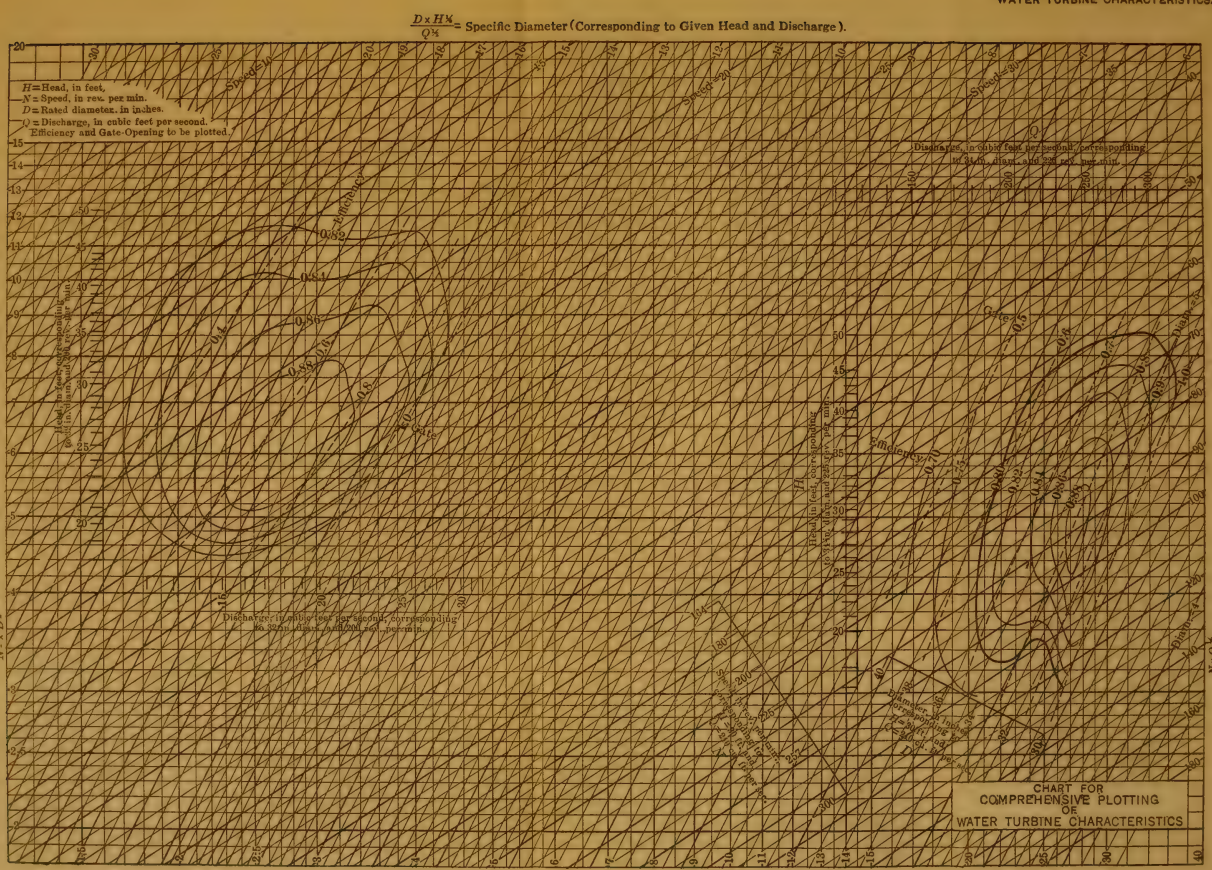
Knowing that $H = 30$ ft. and $Q = 240$ cu. ft. per sec., the scale of "specific r. p. m." can be easily converted into one of speed expressed in revolutions per minute. This scale has been added to the chart at N. Only those speeds are marked, which will give the required 60 cycles per sec. Similarly, the scale of specific diameters can be easily converted into one of diameter expressed in inches. This scale has been added to the chart at D. Only those diameters are marked, which the manufacturer can furnish from stock patterns.

The speed and diameter may then be chosen so that the turbine will do its best under the given conditions of operation. The chart shows that, at 225 rev. per min., a 34-in. wheel will operate at near its peak efficiency and, at the same time, allow efficient operation at a considerable reduction in head and increase in discharge. Hence, this speed and diameter are determined on.

Then, knowing $N = 225$ rev. per min. and $D = 34$ in., the scale of specific heads can be easily converted into one of head expressed in feet, and the scale of specific discharges into one of discharge expressed in cubic feet per second. These scales have been added to the chart at H and Q and enable the performance of the selected wheel to be predicted under all conditions of operation. For example, the chart shows:

Under a 24-ft. head: a gate-opening of about 0.64 will pass a discharge of about 180 cu. ft. per sec., without the efficiency going below 80%; a 0.90 gate will pass about 240 cu. ft. per sec., at an efficiency of 87%; and full gate will pass about 260 cu. ft. per sec., at an efficiency of 84 per cent.

Under a 32-ft. head: a gate-opening of about 0.60 will pass about 190 cu. ft. per sec., without the efficiency going below 80%; an 0.80 gate will pass about 250 cu. ft. per sec., at an efficiency of 88%; and full gate will pass about 290 cu. ft. per sec., at an efficiency of 83 per cent.


$\frac{D \times H^{\frac{1}{2}}}{Q^{\frac{1}{2}}}$ = Specific Diameter (Corresponding to Given Head and Discharge).
H = Head, in feet.
N = Speed, in rev. per min.
D = Rated diameter, in inches.
Q = Discharge, in cubic feet per second.
Efficiency and Gate-Opening to be plotted.
Discharge, in cubic feet per second, corresponding to 36" rated diameter and 100 rev. per min.
Head, in feet, corresponding to 36" rated diameter and 100 rev. per min.
Discharge, in cubic feet per second, corresponding to 36" rated diameter and 1000 rev. per min.
$\frac{H \times 10^7}{N^2 \times D^5}$ = Specific Head (Corresponding to Given Speed and Diameter).
$\frac{N \times Q^{\frac{1}{2}}}{H^{\frac{3}{4}} \times 10^{\frac{1}{4}}}$ = Specific R.P.M. (Corresponding to Given Head and Discharge). (Numerically Equal to "Specific Speed" at 88% Eff.).
CHART FOR
COMPREHENSIVE PLOTTING
OF
WATER TURBINE CHARACTERISTICS
$\frac{Q \times 10^6}{N \times D^3}$ = Specific Discharge (Corresponding to Given Speed and Diameter).

The peak efficiency of approximately 88.5% will be attained at about 0.82 gate, with a discharge of 240 cu. ft. per sec., under a 28-ft. head, and nearly if not quite as high efficiency under the normal head and discharge of 30 ft. and 240 cu. ft. per sec., at 0.79 gate.

To supplement the added scales of head and discharge, a set of curves showing actual horse-power delivered under all conditions could be added very easily, running in the upper left to lower right direction.

To illustrate the fact that distance, regardless of location, on the chart is a measure of range of operation, scales of discharge, in cubic feet per second, and head, in feet, have been added in the left-hand portion of Plate XI to show the performance of a 32-in. wheel of low specific speed, operating at 200 rev. per min. Note that the spacing of these discharge and head scales is identical with that of the discharge and head scales for the high specific speed wheel at the right.

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PAPERS AND DISCUSSIONS

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THE SILT PROBLEM OF THE ZUNI RESERVOIR*

By H. F. Robinson, Assoc. M. Am. Soc. C. E.

Synopsis.

This paper discusses the silting up of reservoirs in the arid part of the United States, with special reference to the Zuni Reservoir in New Mexico, which shows a loss of capacity of 60.7% in 12½ years.

In all reservoirs built in the western part of America, and especially in those built in a stream bed by damming the channel, the silt problem is one that must be faced sooner or later; and unless some means can be found for removing the silt deposits, the accumulation will impair, materially, the storage capacity of the reservoir, and, at some date, controlled by local conditions, the entire basin will be filled to the brim.

This is particularly true of the ephemeral, flashy streams, dry a considerable portion of the time and subject to freshets and floods at intervals. At such times the floods of water coming down the dry beds will erode the bottoms and banks to a great extent, much more so than if the stream bed was continually wet, and the accumulation in the reservoir will be much greater when the reservoir is in the stream channel, as the entire débris of the erosion, whether carried in suspension by the water or rolled along the bottom, will be deposited in the reservoir.

The Zuni Reservoir is in the Zuni Indian Reservation in Western New Mexico, about 45 miles south of Gallup. It is formed by the

* This paper will not be presented before any meeting of the Society, but written communications on the subject are invited for subsequent publication in *Proceedings* and with the paper in *Transactions*.

construction of a dam across the Zuni River, a tributary of the Little Colorado.

The dam is a combination rock and hydraulic fill, and was built by John B. Harper, M. Am. Soc. C. E., Superintendent of Irrigation in the U. S. Indian Irrigation Service. The rock fill has a height of 80 ft., or from the bottom of the puddle trench to the top of the parapet 110 ft., the length over all being 780 ft. There are 40 000 cu. yd. of rock in the fill, and 60 000 cu. yd. of the hydraulic fill. At the point where the dam is built, the stream has cut through a lava flow, and the two abutments are composed of the lava or basalt.

The reservoir was built between 1902 and 1907, the gap in the stream being closed in 1906, from which time water was impounded; but, until August, 1909, only a small portion of the reservoir capacity had been stored.

In September, 1909, the water in the reservoir reached the spillway lip, and, it is supposed, found vertical cracks in the basalt south abutment of the dam, allowing the water to reach a stratum of sand under the basalt, causing a subsidence of the mesa, which wrecked the spillway and damaged the end of the dam.*

As originally constructed, the spillway of the Zuni Reservoir was at Elevation 1 000, but when the new spillway was built, it was placed 9 ft. lower. It was planned that when more storage capacity was needed some form of stop was to be placed in the spillway, either a permanent weir, or gates of some kind, with the top edge at the old elevation, and proper foundations were placed under the floor of the spillway to allow for this.

The quantity of silt brought into this reservoir is very great, and in the 12½ years since the channel was closed, has amounted to about 4.86% per annum of the reservoir capacity to the elevation of the present spillway.

Soundings were made in the reservoir in June, 1910, January, 1912, January, 1914, and January, 1918, in order to ascertain the quantity of silt deposited, and with the exception of the first period (from June, 1906, to June, 1910), when the run-off was not carefully measured, the run-off records have been kept with considerable accuracy; and

* An article describing this failure appeared in *Engineering News*, Vol. 62, pp. 597 to 600, and an article relative to the flood of that time, and an attempt to find the relation between the records of the run-off and rainfall appeared in *Water Supply Paper No. 269* of the U. S. Geological Survey, p. 206. This same article also appeared in *Engineering News*, Vol. 64, pp. 203 and 204.

as the last three sets of soundings were taken through the ice, and the measurement points located with a transit, it is thought that the results obtained are of considerable accuracy.

During the first period, which was 4 years, the quantity of silt deposited was 1 804 acre-ft., an average of 451 acre-ft. per year. During this period, the estimated flow was 56 140 acre-ft., which is thought to be slightly in excess of the actual flow; but, assuming it to be correct, the quantity of silt deposited was 3.2% of the run-off.

During the second period (1½ years), the silt deposit amounted to 1 340 acre-ft., or 894 acre-ft. per year. The run-off was 24 630 acre-ft., and the silt was 5.4% of this flow.

The third period (2 years) had a run-off of 14 360 acre-ft. The silt deposited was 1 056 acre-ft., or 528 acre-ft. per year, and the percentage of silt to the run-off was 7.3, the greatest in any period.

During the fourth period, the conditions of run-off were very different. The seasons were wet, and although the run-off was many times the quantity of the former periods, the silt deposited seems to have been considerably less than in former years. There is found to be a total deposit for the 4 years of 1 307 acre-ft., or 329 acre-ft. per year, but as the run-off for the period was 226 195 acre-ft., the silt percentage was only 0.58.

For the total period of 12½ years, the run-off has been 326 648 acre-ft., the silt deposit, 5 507 acre-ft., and the average silt content, or deposit of the water, 1.88 per cent.

In addition to this silt deposit, which only represented the quantity left in the reservoir, a considerable quantity has been carried out of the reservoir through the gate-valves, and, during the last period, it is probable that a large quantity carried in suspension passed over the waste-way. Considerable water has been wasted through the valves back into the river, it having been necessary to do this, especially of later years, in order to keep the valves clear, and some muddy water was drawn off for use on the fields.

It was estimated by the Engineer in Charge that each year during the third period, at least 50 acre-ft. of silt went to the fields and at least three times this quantity went back to the river, through the valves, with the waste water. How much has been carried out during the past four years, or what proportion of silt was in the water going

out the waste-way, there are no records to show, but the quantity is not inconsiderable. (See Table 1.)

TABLE 1.—Silt Deposit in the Zuni Reservoir from Original Closing of Channel in 1906, to January 1st, 1919.

All Capacities and Silt Deposits in Acre-Feet.

	Original, 1906.	June, 1910.	Jan., 1912.	Jan., 1914.	Jan., 1918.	Jan., 1919.	Total period.
Total silt deposit	0	1 804	3 144	4 200	5 507	6 186	6 186
Length of period, in years	.....	4	1½	2	4	1	12½
Silt deposit for period	.....	1 804	1 340	1 056	1 307	678	6 185
Silt per year, average	.....	451	894	528	327	678	494
Total run-off	.....	56 140	24 630	14 360	226 195	5 323	326 648
Percentage of silt in run-off	.....	3.2	5.4	7.3	0.58	12.5	1.88
At Contour 990:							
Capacity	10 230	8 409	7 069	6 013	4 706	4 028	4 028
Percentage remaining of original capacity	.....	82.3	69.2	58.8	46.0	39.3	39.3
Lost capacity per year in percentage of original	.....	4.4	8.8	5.2	3.2	6.7	4.86
At Contour 1 000:							
Capacity	15 811	13 969	12 632	11 562	10 218	9 540	9 540
Percentage remaining of original capacity	.....	88.4	80.0	73.1	64.6	60.3	60.3
Lost capacity per year in percentage of original	.....	2.9	5.6	3.48	2.1	4.3	3.17

Life of reservoir, Contour 990 = 21 years. Spillway at Contour 991. Capacity between Contours 990 and 991 = 507 acre-ft.
Life of reservoir, Contour 1 000 = 32.4 years.

Considering the reservoir at its present construction (see Table 2 and Fig. 1), the original capacity at Contour 990 (1 ft. below the present spillway lip), was 10 213 acre-ft. At the end of the first four years, it was 8 409 acre-ft., a loss of 4.4% each year, leaving the capacity 82.3% of the original. At the end of the next year and a half the capacity was 7 069 acre-ft., a loss of 8.8% per annum, with

Fig. 1.

69.2% of the capacity of the reservoir remaining. At the end of the third period (two years later), the capacity was 6 013 acre-ft., a loss of 5.2% per annum. At the end of the next period, the capacity was 4 706 acre-ft., or only 46% of what it had been 11½ years before; and, at the end of the last period, the capacity was only 4 028 acre-ft., 39.3% of its original capacity. The average capacity lost each year was 4.86%, and the average lost per year for the entire 12½ years was 4.86 per cent.

This means that the life of the reservoir to Contour 990 will be a little more than 21 years, of which 12½ years have passed. At this rate, the reservoir will be silted to within 1 ft. of the spillway level by June, 1926, and within a couple of years from the time of this writing (1919), the storage capacity will have been so impaired that it will not store enough water to carry the project over a normal year, and certainly not enough from a wet year to tide the project over a dry one.

TABLE 2.—Capacities, in Acre-Feet, of the Zuni Reservoir at Various Times, Showing Its Reduction by Silt Deposits.

Contour.	1906.	June, 1910.	January, 1912.	January, 1914.	January, 1918.	January, 1919.
940	0	.....	.....	.....	.....	.....
945	7	.....	.....	.....	.....	.....
950	53	.....	.....	.....	.....	.....
955	198	.....	.....	.....	.....	.....
960	591	0	0	.....	.....	.....
965	1 345	185	1	.....	.....	.....
970	2 569	990	249	16	0	.....
975	3 758	2 256	1 190	407	53	12
980	5 563	3 920	2 673	1 729	786	706
985	7 763	5 997	4 679	3 625	2 330	1 652
990	10 213	8 409	7 069	6 013	4 706	4 028
991	.....	.....	.....	.....	5 213	.....
995	12 887	11 062	9 721	8 664	7 336	6 660
1 000	15 811	13 969	12 632	11 562	10 218	9 540

Similar data have been worked out with the spillway restored to the 1 000-ft. contour. (See Table 2.) At the present time, there remains only 60.3% of the original capacity of the reservoir, and its extreme life is about 32½ years, or, by 1939, the entire reservoir will be filled to the brim—unless, in the meantime, some method can be devised to remove the silt, or a considerable portion of it.

The quantity of silt deposit shown by these measurements may seem to be very large to one who has not made a study of the streams of the arid Southwest, especially the ephemeral streams where there is little or no clear water run-off, the entire annual discharge being quick floods after the summer rains or in the spring when the snows of the

higher elevations melt. Lake McMillan, in New Mexico, is reported to have silted up 60% in 15 years.* Taking the Zuni Reservoir at the 990-ft. contour, the percentage of filling would be about 70 in 15 years, and using the capacity of the reservoir at the 1 000-ft. contour, about 48 in the same time. In the reports concerning the Austin Dam, it is stated that in the 4 years, from 1893 to 1897, the reservoir was silted up 38% of the original capacity, and during the period of 7 years, from 1893 to 1900, it had silted up 48 per cent.

Mr. W. W. Follett† gives 1.66 as the mean percentage of silt carried by the Rio Grande, at San Marcial, N. Mex., from 1897 to 1912, inclusive. For the same period, the maximum was 4.14% in 1911 and the minimum 0.78% in 1905. He mentions the maximum for one day—October 7th, 1911—as 14.87% and the monthly mean of 7.9% for the month of October, 1911. It is probable that the maximum mentioned by Mr. Follett, namely, 14.87%, would represent about the maximum quantity ordinarily carried in suspension. There are exceptions, as will be shown later.

Some experiments made by Rollin Ritter, Assoc. M. Am. Soc. C. E., Engineer in Charge of the Zuni Reservoir, leads him to the following conclusions regarding the silt-ladened waters of the Zuni River, and some general conclusions regarding the quantity of silt that may be transported in some of these Southwestern streams. A report made by him in 1914, to the writer, contains the following statements:

"The silt-ladened waters being heavier than the clear, ofttimes appeared at the tunnel outlet when the reservoir surface was clear and a small or moderate flood was entering the reservoir. During one period, when the water wasted appeared very heavily charged with silt, a sample was taken at the tunnel outlet. This bottle test showed percentages of silt by volume at various times about as follows:

Time after collecting sample.	Apparent % of silt.
1 day	55
7 days	35
1 month	25
3 months	17½
4 months	16

"At the latter time, the silt in the bottle was compact and even showed lamination marks and probably no more shrinkage would have

* Third Annual Report of the U. S. Reclamation Service.

† *Engineering News*, January 1st, 1914 (Vol. 71, p. 18).

occurred. In the earlier periods when a sliver was plunged through the mouth of the bottle into the silt, the line of demarcation between the surface of the silt and supernatent clear water was not sensible to the touch. Unfortunately, the bottle containing the sample froze and burst, and the observations for a longer period could not be made.

"The above may illustrate why so many engineers regard the bottle test as worthless. It may also explain why some enormous percentages have been reported at times from various sources, *i. e.*, the silt as first observed will eventually shrink to one-third or even one-fourth the volume observed in the freshly gathered sample.

"No tests are available to solve the question of how much was carried by the water in suspension, and how much rolled down the stream bed. The latter is, however, a large proportion of the former."

Some measurements made by the writer on Bonito Creek near Fort Defiance, Arizona, gave something over 13% of sediment after the sample had stood 30 days. The most remarkable instance of large quantities of sediment carried by water was observed in the Moencopi Wash on the Painted Desert of Arizona. During a flood on this stream, a sample was dipped up from about the center of the thread of the stream and allowed to settle for two days, and remarkable as it may seem, at the end of that period, there was 15% of turbid water and 85% of sediment, showing that the flow of the stream was practically liquid mud. The sample was upset before it had time to settle further, but it is probable that a settlement of 30 days would have shown not less than 50% of solid matter.

Unfortunately, the Zuni Reservoir is situated in the bed of the stream, and all silt whether carried in suspension or rolled along the bottom of the stream bed is caught in the reservoir, except the comparatively small quantity that passes out through the valves, and the lighter portion of the sediment which is held in suspension and passes over the spillway at times when the water is flowing into the full reservoir. We have here a fairly large basin and a moderately high dam, and the entire closing up of the channel. "The greater the height of the dam or size of reservoir, the greater will be the rate of filling."* This is the opinion of the late H. F. Labelle, M. Am. Soc. C. E., after an examination of the silt question in many reservoirs and behind many dams both in the United States and in India. It

* *Engineering News*, Vol. 60, p. 212.

will be seen, therefore, that in the case of this reservoir all conditions are favorable for the retention of large quantities of silt.

The area of the water-shed tributary to the Zuni Reservoir has been quoted as 650 sq. miles. From this, however, should be deducted the area above the Ramah Dam and a considerable area of rolling country where the drainage flows into natural shallow tanks or basins. Unless there is a cloudburst, there is no overflow from these natural basins, and the precipitation rarely if ever runs into the Zuni River. It is thought that 500 sq. miles more closely represents the real area of the water-shed draining into the Zuni Reservoir.

There are no records of the rainfall in this drainage area, and a study of the run-off divided into periods, as given in Table 3, will show that the precipitation is very irregular. During the two years, January, 1912, to January, 1914, the average run-off was less than 7 200 acre-ft., while from January, 1914, to January, 1918, the average run-off exceeded 56 000 acre-ft. It is probable that the average annual rainfall of the water-shed is between 10 and 16 in., and until rainfall records are available on the water-shed, no relation between the rainfall and the run-off can be determined.

It is generally believed that the quantity of silt carried by any stream is largely in proportion to the magnitude of the floods, but, according to the records at Zuni, little relation is found between the magnitude of the flow and the silt carried. During the period from 1906 to 1910, with an average annual run-off of more than 14 000 acre-ft., the percentage of silt deposit was 3.2. In the next year and a half, with an average run-off of 16 420 acre-ft., the silt deposit was 5.4 per cent. During the next period of two years, with a minimum run-off amounting to a little more than 7 000 acre-ft. per year, the silt deposit was 7.3% of the total, while in the last period of four years, with an average annual run-off of more than 56 000 acre-ft., it was a little more than one-half of 1% (0.58%), and for the total period of $11\frac{1}{2}$ years, the solids deposited from the run-off were 1.71 per cent.

In estimating the probable life of the reservoir, the percentage of silt in the run-off has been neglected, and the annual average quantity of silt actually deposited has been used.

In an article* by Herman Stabler, M. Am. Soc. C. E., and Mr. Horatio M. Parker, regarding the silt carried by the Kaw River, they

* *Engineering News*, Vol. 63, p. 644.

state that, in June, 1908, the river carried 41.4%, and in May, June, July, and August, 1908, 80.7% of the total for two years. From this they deduce: "The extraordinary influence of great floods, in erosion and denudation, is clearly shown." While this may be true of the flow of large rivers, it does not seem to be true in the case of the flashy streams of the Southwest, where the lesser volume of water in a year, coming in a few periods of run-off, seems to carry the greatest quantity of silt.

TABLE 3.—SHOWING RUN-OFF, IN ACRE-FEET, OF THE ZUNI RIVER, AT BLACKROCK, N. MEX.

Total run-off for 1906 and 1907, 38 000 acre-ft.
January to June, 1908, 2 200 acre-ft.
July to September, 1908, 2 900 acre-ft.
October, 1907, to June, 1908, 500 acre-ft.

	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.	1918.
January	.....	2 540	1 460	.....	.....	1 750	48	11 771	40	40
February	.....	.....	1 340	350	.....	2 930	4 604	23 560	712	880
March	.....	500	5 200	.....	1 380	5 190	26 695	71 880	1 232	1 240
April	.....	.....	.....	400	1 420	800	13 737	13 177	354	0
May	.....	.....	.....	.....	.....	1 200	5 078	55	134	28
June	.....	.....	.....	.....	.....	200	808	.....	98	558
July	1 160	1 800	8 820	1 800	1 380	7 200	1 204	1 444	.....	.....
August	5 500	2 100	1 660	1 190	300	800	1 859	1 275	600	860
September	2 840	150	760	.....	3 480	500	740	1 320	505	760
October	.....	.....	1 340	380	2 200	450	.....	22 068	102	422
November	.....	.....	.....	.....	120	.....	28	38	.....	515
December	.....	.....	.....	.....	50	130	10	.....	.....	20
	9 500	7 090	20 580	4 030	10 330	21 150	54 811	146 588	3 777	5 323

Total run-off, 1906 to 1918, inclusive, 326 779 acre-ft.

It has occurred to the writer that the great difference in the quantity of silt carried by the water may be explained, to a certain extent, by the fact that during the periods of lesser run-off the ground in the water-shed and the stream bed are very dry and, consequently, easily eroded by the floods, and that during the periods of greater run-off, more evenly distributed, the ground and the stream channels are kept moist and are, therefore, not subject to as great erosion during the beginning of heavy precipitation and run-off.

A remedy is not easily suggested. The situation involves a serious fact, not a theory, and at a very early date it will be necessary to put into practice some method of getting rid of the silt. Otherwise, a

project built at a cost of more than $500 000, under which more than 3 500 acres are now being cultivated, and products valued at more than $68 000 were raised last year by the Indians, will have to be abandoned inside of 20 years. It will be necessary to raise the spillway elevation within a year or two, for the entire capacity of the reservoir to-day is only slightly in excess of one year's need for the present area of cultivated land.

Certain remedial measures have been suggested. One of these is to construct a set of small overflow dams in the stream above the reservoir. Even if these could be successfully constructed, and maintained at a reasonable cost, the silt accumulation of one year would fill a small one, and the ultimate filling of the main basin would be postponed only a short time.

It also has been suggested that much of the silt comes from the rapid cutting of the banks of the stream, and that rip-rapping these banks at the critical points would prevent further erosion and reduce the quantity of silt coming into the reservoir. The main stream is too long to make this feasible, and it has not been observed that the waters were any less heavily charged with silt at the head-waters of the feeder streams than in the main stream.

It also has been suggested that large sluices be installed at a low elevation, and the silt be gotten rid of in that manner; but observation in cases where dams have given way and the entire content of water run out through the opening, discloses that the quantity of silt sluiced out has been almost negligible.

The St. Johns Reservoir, in Arizona, the Austin Reservoir, and others, would indicate that a channel no wider than the opening, and extending back for a short distance, with almost vertical sides, would be the result.

The only plan that sounds at all feasible is that outlined roughly by the Consulting Engineer, J. H. Quinton, M. Am. Soc. C. E., when he was on the project some years ago.

This plan was to have a floating pipe line, connected with the lowest valve on the tower, now below the bottom of the reservoir. On a barge out in the lake, a cutter and nozzle were to be mounted, with a gasoline engine for power to operate the cutter, and a small vacuum pump. With a flow started through this pipe line, no power would be required to continue such flow other than the operation of the vacuum pump

which would be placed at the highest point on the pipe line. What is really a suction dredge would thus be provided, and if all the water drawn from the reservoir was taken out in this manner, large quantities of silt could be removed.

Possible objections would be that in dry seasons there would not be sufficient water to waste, and all the water, heavily ladened with silt, would have to run into the canal, and, without a silt trap, it might fill up the two siphons in the canal. If it did not do this, much silt would be deposited in the canal and cause considerable expense and trouble for its removal.

It is thought that some means of combatting the silt will be evolved, but, with the rapid filling up of the reservoir, steps should be taken at once to find a solution of the problem.

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PAPERS AND DISCUSSIONS

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THE ACCURACY OF WATER LEVEL RECORDERS AND INDICATORS OF THE FLOAT TYPE*

By J. C. Stevens, M. Am. Soc. C. E.

Synopsis.

The continued advancement of hydraulic engineering is demanding a more extensive use of automatic devices for recording and indicating water levels.

Modern hydro-electric plants are not complete without indicators on the switchboard or devices that record the water levels in forebay, tail-race, net head on the turbines, or levels in some distant reservoir or supply canal. Every water supply investigation involves the recording of water levels in some manner, and no irrigation system can be operated successfully without obtaining and analyzing extensive records of water heights.

This paper is an inquiry into the degree of accuracy that may be expected from the use of automatic recorders and indicators of the float type. It shows that standard instruments now on the market are, in general, sufficiently accurate for most practical purposes, but that where an extraordinary degree of accuracy is required, certain corrections may be applied to the indicated or recorded heights, by which the true heights may be ascertained.

* This paper will not be presented for discussion at any meeting of the Society, but written communications on the subject are invited for subsequent publication in *Proceedings* and with the paper in *Transactions*.

Sources of Error.

In Fig. 1 is shown the general principle on which all float-operated instruments depend. A float rises and falls with the water, which, by means of a line consisting of a cord, cable, tape, or chain, running over a pulley and counterpoised, operates the pen, pencil, indicating hands, or dials of the instrument. In rare cases, a solid rod or rack is used, but the effect is, in general, similar to the use of a counterpoised line.

With a counterpoised line there are three sources of error, which cause the indicated heights to deviate from the true heights:

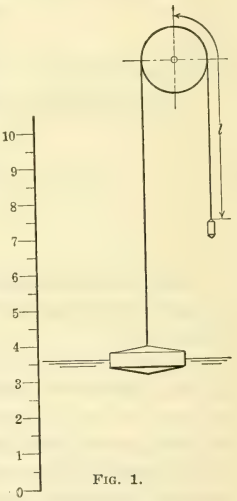

Fig. 1.

1. In operating the instrument there is always a certain amount of mechanical work which the float performs. Hence, the indicated heights on a rising stage differ from those on a falling stage by an amount proportioned to the force required to operate the device. This error will be called "float lag."

2. With every change of stage a portion of the line passes from one side of the float pulley to the other. Hence, the indicated heights deviate from the true heights by an amount depending on the range of stage and the unit weight of the line. This error will be called "line shift."

3. As the float rises the counterpoise and a portion of the line become submerged, unless provision against submergence is furnished. Hence, the indicated heights deviate from the true heights by an amount depending on the weight and specific gravity of the line and counterpoise. This error will be called "submergence of counterpoise."

In analyzing the effect of these three sources of error, the following notation, in foot and pound units, will be used:

Let W = weight of float.
c = weight of counterpoise.
u = weight per foot of the line.

L = total length of the line.
l = portion of the line on the counterpoise side of the pulley. (See Fig. 1.)
D = diameter of float.
A = area of float.
h = elevation of the liquid or gauge height.
h_1 = gauge height corresponding to submergency of counterpoise.
P = pull of the line on the float.
F = force required to operate the instrument.
w = weight per cubic foot of water or other liquid.
x = depth of flotation of the float with counterpoise in air.
x' = depth of flotation of float with counterpoise submerged.
r and f = subscripts for rising and falling stages, respectively.
s_c = specific gravity of the counterpoise.
s_l = specific gravity of the line.

Correction for Float Lag.

With the float resting on the water and the line attached thereto, as shown in Fig. 1, we have:

$$w\,A\,x = W - P \quad \ldots\ldots (1)$$

on a rising stage, the pull is,

$$P_r = c - F - u\,(L - 2\,l) \quad \ldots\ldots (2)$$

and, on a falling stage,

$$P_f = c + F - u\,(L - 2\,l) \quad \ldots\ldots (3)$$

Substituting Equations (2) and (3) in Equation (1), we have for rising stage:

$$x_r = \frac{W - c + F + u\,(L - 2\,l)}{w\,A} \quad \ldots\ldots (4)$$

and, for a falling stage,

$$x_f = \frac{W - c - F + u\,(L - 2\,l)}{w\,A} \quad \ldots\ldots (5)$$

Subtracting Equation (5) from Equation (4):

$$x_r - x_f = \frac{2\,F}{w\,A} = \frac{8\,F}{w\,\pi\,D^2} \quad \ldots\ldots (6)$$

Equation (6) gives the lag of the float between the rising and falling stages. It varies directly with the force required to operate

the instrument and inversely as the square of the diameter of the float. To make this error as small as possible, the friction and mechanical work of the instrument should be reduced to a minimum, and the float should be as large as practicable. This lag can never be entirely eliminated.

The force, F, consists of friction in bearings, gears, etc., of the pen or pencil on the paper, work of bending the line over the pulley, and, in the case of long-distance instruments, of making electrical contacts. It will vary with the condition of the instrument as regards oiling, freedom from dirt, etc., and may become inordinately large if the instrument is neglected. It is readily measured by balancing two weights equal to that of the counterpoise on a short piece of line over the pulley. Then, with the aid of a delicate spring balance or scales, the weight required to move the indicator is easily determined.

It has been proven experimentally that if the indicator is set to show the true height on a rising (falling) stage, then the true height on a falling (rising) stage at the same gauge height may be obtained by subtracting (adding) the quantity, $\frac{8\,F}{W\,\pi\,D^2}$, given in Equation (6). With a value of $F = 1$ oz., and an 8-in. float in water, this correction amounts to 0.006 ft.

In general practice, this is a negligible error, but the writer has seen several indicating gauges, where bottles were used for floats, sprocket chains for line, and the counterpoise was an iron index running in grooves over the face of a graduated staff, where this error amounted to 0.25 ft., or more.

It has been found experimentally that the friction factor increases with the weight of the counterpoise; in other words, with the weight on the pulley shaft.

To insure results within a reasonable limit of error, therefore, use a large substantial float, a small counterpoise, a light flexible line, and keep the instrument in good condition.

Correction for Line Shift.

The general equation for depth of flotation of the float is:

$$w\,A\,x = W - c \pm F + u\,(L - 2\,l) \ldots\ldots\ldots\ldots (7)$$

in which F is + for a rising and — for a falling stage. We may also write :

$$w\ A\ (x + \delta\ x) = W - c \pm F + u\ L - 2\ u\ (l + \delta\ l) \ldots\ldots (8)$$

whence,

$$\delta\ x = -\frac{2\ u}{w\ A}\ \delta\ l;$$

but $\delta\ l$ is the change in stage, that is,

$$\delta\ l = h_1 - h_0$$

whence,

$$\delta\ x = -\frac{2\ u}{w\ A}\ (h_1 - h_0) \ldots\ldots\ldots\ldots\ldots\ldots (9)$$

Equation (9) gives the correction for line shift. Obviously, the indicator may be set to show the true height at any gauge height, h_0. Then the correction to be applied is $-\frac{2\ u}{w\ A}\ H$, where H is the height above or below that point.

For a $\frac{1}{16}$-in., galvanized-iron sash cable, weighing 0.0065 lb. per ft., attached to an 8-in. float in water and a 10-ft. change in stage, this correction amounts to — 0.006 ft. In the case of the indicating gauges previously cited, however, it amounted to nearly 0.2 ft.

It is negative for both rising and falling stages above the origin of H, or the point at which the indicator is set to show the true height, and positive below.

Correction for Submergence of Counterpoise.

When the counterpoise and any portion of the line are submerged, the pull of the float is reduced and, consequently, the depth of its flotation is increased. The weight of any body submerged in water is reduced an amount $\frac{1}{s}$ of its weight in air, where s is its specific gravity. If submerged in any other liquid, s is to be replaced by its specific gravity with respect to that liquid.

When the counterpoise and a portion of the line become submerged, Equation (7) must be written:

$$w\ A\ x' = w \pm F - \left(l - \frac{1}{s_c}\right) c + \left(l - \frac{1}{s_l}\right) u\ (L - 2\ l) \ldots (10)$$

Subtracting this from Equation (7), we have,

$$x - x' = \frac{c}{s_c\ w\ A} - \frac{u\ (L - 2\ l)}{s_l\ w\ A}$$

Now, at the point of submergence, $l = \frac{1}{2} L$. Consequently, the last term in the above equation disappears, and we have,

$$x - x' = \frac{c}{s_c \, w \, A} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (11)$$

For a $1\frac{1}{4}$-lb., lead counterpoise and an 8-in. float in water, this correction amounts to 0.005 ft. This correction is always positive and tends to compensate for the error of "line shift."

Correction for Line Shift After Counterpoise is Submerged.

After submergence of the counterpoise, we may obtain a new value of the correction for line shift directly from Equation (9) by writing:

$$\delta x' = \frac{2\left(l - \frac{1}{s_1}\right) u}{w \, A} (h_2 - h_1) \quad \ldots\ldots\ldots\ldots\ldots (12)$$

For a $\frac{1}{16}$-in., galvanized-iron sash cord, attached to an 8 in. float in water, this correction amounts to 0.005 ft. for a 10-ft. change in stage, or 0.001 ft. less than for the counterpoise running in air.

Correction Diagrams.

The foregoing corrections are best applied in practice by preparing a correction diagram from which the combined corrections may be applied to the indicated heights to ascertain the true heights.

It is to be remembered that most instruments in good condition, if properly installed, will indicate or record the true height within a reasonable limit of error. It is only in cases where extraordinary accuracy is desired that these corrections need be applied. For example, in making tests of pumping plants where discharges are fluctuating and it is desired to secure continuous records of the head on a discharge measuring weir to within 0.001 ft.; or, again, if it is desired to measure the evaporation from a tank or reservoir, or the quantity of oil pumped into and withdrawn from a tank. In such cases, continuous records are required to a much greater degree of accuracy than in the ordinary practice of hydrometry.

Wherever such exigencies exist, they can be met by the use of ordinary recording instruments by applying the necessary corrections.

In order to prepare a correction diagram, it is necessary first to determine the constants of the instrument and its installation.

A prime requisite for all installations is a stilling chamber in which the float may move without being influenced by wave action, and where the line may be protected from wind.

Once installed, it is necessary to measure:

1. The diameter of the float;
2. The weight of the counterpoise and line;
3. The gauge height at which the counterpoise is submerged; and
4. The force, in pounds, required to move the indicator.

To illustrate, a numerical example will be taken: The float has a diameter of 8 in. and weighs about 4 lb. The counterpoise is of lead, weighs $1\frac{1}{4}$ lb., is 0.2 ft. long, and is submerged at a gauge height of 5.0 ft. The line is $\frac{1}{16}$-in., galvanized-iron sash cord, weighing 0.0065

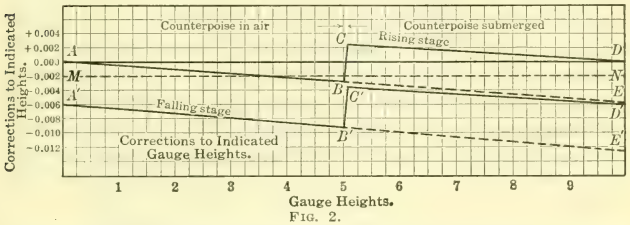

FIG. 2.

lb. per ft., and has a specific gravity of 6, since it has a hemp center. The force required to move the recorder pencil is 1 oz.

Substituting these values in the equations previously given, the following corrections are obtained:

1. For "float lag", Equation (6), the correction between a rising and falling stage is 0.006 ft.

2. Correction for "line shift" with counterpoise in air, Equation (9), is $-\ 0.0006\ (h_1 - h_0)$ ft.

3. Correction for "line shift" with counterpoise submerged, Equation (12), is $-\ 0.0005\ (h_2 - h_1)$ ft.

4. Correction for submergence of counterpoise, Equation (11), is $+\ 0.005$ feet.

We have two correction lines—one for a rising stage and another exactly parallel at a distance of 0.006 ft., for the falling stage. These corrections are plotted in Fig. 2. The corrections for a rising stage are given by the line, *ABCD*, and those for the falling stage by

A' B' C' D', which is parallel thereto and 0.006 ft. below. The lines, *AB* and *A' B'*, have a slope of 0.0006 ft. per ft., and the lines, *CD* and *C' D'*, have a slope of 0.0005 ft. per ft. The lines, *BC* and *B' C'*, are the correction of 0.005 ft. for submergence of the counterpoise, which occurs in 0.1 ft. of gauge height.

If the counterpoise is run in a pipe from which the water is excluded, then the lines, *AE* and *A' E'*, represent corrections.

These lines are plotted on the assumptions that the pencil is set to record the true height at zero gauge height on a rising stage. In practice, the pencil must be set to record the true height at whatever height the water happens to be.

In order to obviate the necessity of constructing a new correction diagram for each setting, the correction lines may be drawn on a sheet of tracing paper. Then, by shifting this sheet up or down over the scale of gauge heights, the corrections for any setting are readily obtained. For example, the pencil was set so that it indicated the true height on a rising stage at a guage height of 3.5 feet. Then, shift the tracing paper until the correction line, *ABCD*, for a rising stage, intersects the gauge height line of 3.5 ft. at the origin of corrections. This is equivalent to moving the origin of corrections to the line, *MN*, in Fig. 2.

Any instrument may be set on the rising stage by pulling on the line on the side of the float until it is slack below the hand, then slowly releasing it.

It is seen from Fig. 2 that the maximum corrections are less when the counterpoise is allowed to submerge, than when run in a sealed pipe.

Instruments Performing Mechanical Work.

In some types of instruments a certain amount of mechanical work is done in addition to that of overcoming friction. For example, in long-distance recorders, electrical contacts are made at stated intervals of gauge height.

The pen remains stationary until the float has traveled the amount of the contact interval, then it suddenly follows the float that amount. The pen should nominally indicate the true height within an amount equal to the contact interval. However, if the pen is set to indicate the true height just after a contact on a rising stage, it will deviate from the true height just before a contact on the falling stage by an

amount equal to the contact interval plus the float lag due to friction alone.

In Fig. 3 is plotted the results of an actual test on a long-distance recorder. This instrument was one of the manufacturer's earlier types and had a nominal contact interval of 0.05 ft. (actually 0.0479). It was tested with a 10-in. float in a tank in which water and float heights were measured to 0.001 ft.

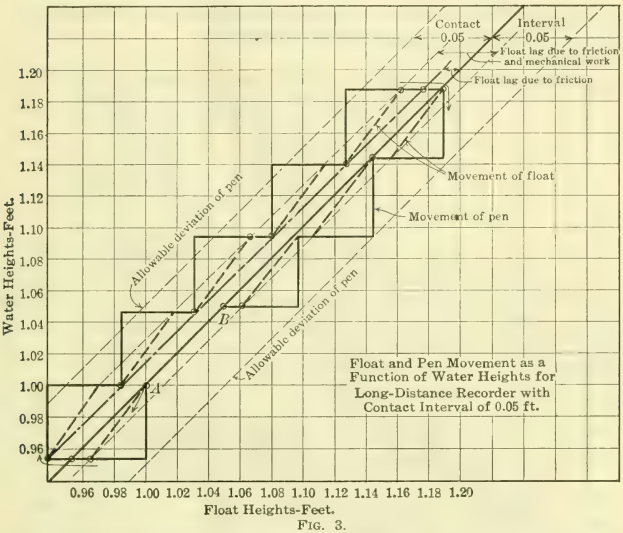

FIG. 3.

The pen was set just after a contact on a falling stage to indicate the true height, at the point *A*. The water was lowered, then raised, and lowered again to the point *B*. The float and pen movements are plotted as functions of water heights.

The float lag due to friction alone was 0.012 ft., and the lag due to friction and mechanical work was 0.036 ft. The pen, however, indicated the true height within the allowable deviation of 0.05 ft., except just before contact on the rising stage, when it exceeded the allowable deviation the amount of the friction lag 0.012 ft.

This error was inappreciable for this type of instrument, but could easily have been reduced by increasing the size of the float.

In Fig. 4 is similarly plotted the results of a test on a long-distance indicator built by the same manufacturers. This instrument had a contact interval of 0.01 ft., and the pen was to indicate the true height within that limit of error. During the test, the deviation was within that limit on the rising stage. On the falling stage, just the instant before contact, this limit was exceeded the amount of the friction lag 0.0007 ft. A 24-in. float was used. The instrument had a total range of 35 ft., but the maximum error due to line shift and submergence of counterpoise was less than 0.002 ft.

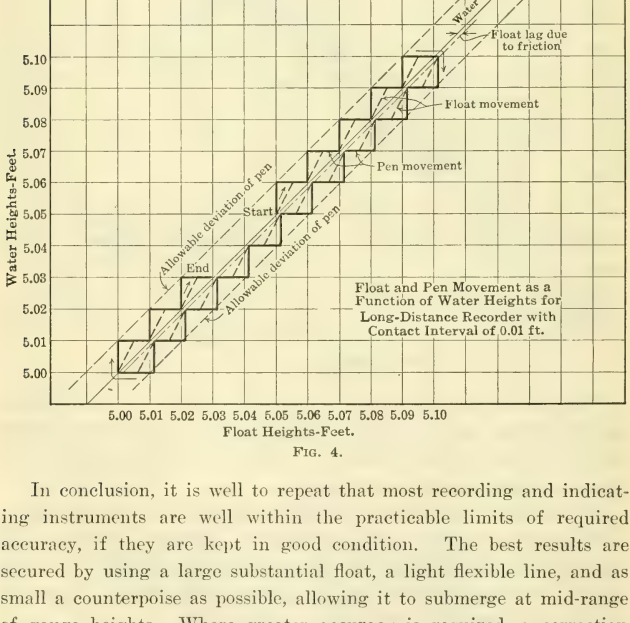

FIG. 4.

In conclusion, it is well to repeat that most recording and indicating instruments are well within the practicable limits of required accuracy, if they are kept in good condition. The best results are secured by using a large substantial float, a light flexible line, and as small a counterpoise as possible, allowing it to submerge at mid-range of gauge heights. Where greater accuracy is required, a correction diagram is readily prepared by which the true heights may be obtained from the recorded heights.

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DETERMINATION OF THE DUTY OF WATER BY ANALYTICAL EXPERIMENT

Discussion.*

By W. C. Hammatt, M. Am. Soc. C. E.†

Mr. Hammatt.

W. C. Hammatt,‡ M. Am. Soc. C. E. (by letter).§—The writer is pleased with the discussion brought forth by his paper, but somewhat disappointed that so little of it had to do with the methods used, and that the main part merely bore on the results obtained on the particular work cited. The intention of the paper was to introduce for discussion and criticism, with a view to improvement in method, the principle of analytical experiment as applied to the determination of the duty of water in irrigation. The two campaigns carried out by the writer in Lake County and Harney County, Oregon, were merely given as examples, with apologies for defects in the methods used, in some cases due to lack of time and necessity for hurried results.

The discussion by Mr. Versluys is interesting in showing results obtained in rice culture in Java, rice being the one cultivated crop comparable in any way with the wild grasses on which the writer's experiments were made. The writer, however, is somewhat surprised at the results, as the average yield—1 000 lb.—is only about 40% of the average yield for California. Possibly this is due to the extreme rainfall conditions in Java, the average annual rainfall varying from 72 to 175 in., distributed throughout the entire year. This would have a tendency to increase the quantity of straw at the expense of the grain, allowing an insufficient dry period for maturing the grain. It

* Discussion of the paper by W. C. Hammatt, M. Am. Soc. C. E., continued from March, 1919, *Proceedings*.

† Author's closure.

‡ San Francisco, Cal.

§ Received by the Secretary, May 13th, 1919.

Mr. Hammatt.

is probable that, if the rainfall were properly distributed, no irrigation whatever would be needed, as the total annual rainfall is in excess of the requirement for rice.

The average quantity of water used in the Sacramento Valley in California for rice culture is about 99 in., the extremes ranging from 53 to 179 in. Of this only about 1½ in. was precipitation during the irrigation season. The irrigation season, by the way, is from the middle of April to the last of October, ranging from 147 to 189 days.

The work of investigation in Texas, mentioned by Mr. Rockwell, will doubtless be of great interest, and the writer hopes that full descriptions of the methods used and results obtained will be published for the benefit of the profession. The writer judges the sampling at various depths and intervals to be for the determination of the distribution of moisture in the soil both during the penetration of the irrigation water and its consumption by evaporation and transpiration.

Mr. Harding's criticism of the addition of 33% to deep-water evaporation rates on account of shallow water is well founded. Mr. Lee's experiments do not justify this as a fixed percentage, and the quantities given by Mr. Sleight are probably more correct for the conditions obtaining on Chewaucan Marsh during the irrigation season, if the increment is considered as due only to the water depth. There are other conditions obtaining on the marsh—which are not encountered in the pan experiments—which tend to increase the evaporation rate, so that, in the aggregate, the 33% increment is probably justified. The condition having the greatest influence is that of the dense plant growth, causing the water to be drawn up the outside of the stalks and the evaporation to be accelerated.

The exception taken by Mr. Harding to the writer's statement that "the ratio of the quantity of water transpired to the quantity of plant matter produced, * * * is within such close limits as to be to a certain extent measurable", is justified on the basis that he makes in his explanatory statement. The writer, however, only intended to apply it to cases where other conditions were equal. In the case of forage crops, where the plant food is taken largely from the air, it holds very closely through a wide range of soil conditions. A seed crop, however, will have a great variation in transpiration ratio, depending on the soil fertility.

As Mr. Stevens makes specific objections to several of the results obtained by the writer, his various points will be answered in the order in which they occur in his second discussion.

The writer had no knowledge of the 6-year record of evaporation at Keno, Ore., at the time of the investigation on Chewaucan Marsh, or, for that matter, at the time his paper was written. Inquiries at the Oregon Agricultural College, the U. S. Geological Survey, and the U. S. Weather Bureau succeeded only in unearthing the Ady record. Had

the writer known of the Keno record, he would have made use of it in preference to the Owens Valley record. Mr. Hammatt.

As for the discrepancy between the writer's tabulation of the Ady record and that published by Moritz, the writer did not, as stated by Mr. Stevens, quote Moritz as his authority, except for those months specifically mentioned. The writer's figures were obtained from photostat copies of the original reports, furnished by the Weather Bureau. As for the difference between the results of the Ady record and that at Keno, the writer cannot agree with Mr. Stevens that it was due to difference in water temperature.

The writer cannot believe that the water temperature has in itself any great influence on the rate of evaporation, within the limits of temperatures usually occurring. According to well-known physical laws, a definite volume of air, at a particular temperature and density, will absorb a definite volume of water vapor, this being dependent on the temperature and density. As saturation is approached, the rate at which the vapor will be absorbed will of course diminish, hence the effect of humidity. If the water is in thin sheets, spray, or capillary form, evaporation will be accelerated. To liberate 1 lb. of water vapor, about 966 B.t.u. must be absorbed by the water. In natural conditions, this heat is absorbed from the atmosphere, which is thus the controlling factor.

Mr. Sleight, in his experiment, placed an electric globe in some of his pans to control their temperature. He thus made the experiment entirely dissimilar to the natural condition of evaporation, supplying the heat necessary to evaporate the water by an artificial heating plant. The fact that the evaporation was greater in the heated than in the unheated pan merely proved that a greater quantity of heat was being supplied to it, which fact was corroborated by the rise in temperature of the water. Under natural conditions, the temperature of the water surface is controlled by the evaporation, rather than the converse. Mr. Sleight did not state in his report the size of the electric globes used, nor the time they were kept lighted. A 40-watt lamp will produce about 3 260 B.t.u. per 24-hour day, sufficient for the evaporation of 3.38 lb. of water, which, in the tanks used in the experiment, would be equivalent to 2.06 in. in depth. A considerable portion of this heat, however, is dissipated through the walls and bottom of the tank.

Also, in the experiments to determine the effect of flowing water on evaporation, the conditions of the experiment were totally unlike any natural conditions. The water was circulated with a centrifugal pump, and, from an inspection of the single record published, the work done by this pump was sufficient to raise the temperature of the water 10 degrees. Although a correction was made for the difference of water temperature by comparison with pans heated by electric globes, it is extremely doubtful whether the relative absorption and evapora-

Mr. Hammatt.

tion from the heat generated by the bulbs would be the same as from that produced by the working machinery. It is the writer's opinion that, under similar conditions, there is likely to be greater evaporation from flowing than from still water, due to surface agitation and to friction with the atmosphere, but this will be an indeterminate variable, and due rather to the relative movement of the wind and water than to the absolute motion of either.

Mr. Stevens states that "the correct figures for evaporation at Ady are already 40% too high, yet the author increases them by 7½% for differences in elevation." If the figures of the U. S. Geological Survey at Keno are accepted, as against those of the Weather Bureau at Ady, which is questionable, the difference is 29% instead of 41 per cent. The effect of elevation, or atmospheric density, however, seems to be open to some question.

Soon after the publication of this paper, the writer had his attention called to the statement that "evaporation at different elevations is in inverse proportion to the barometric pressure." It was immediately apparent that the principle was stated improperly, and he wrote a short discussion correcting the error and making additional explanations of the matter. It was decided, however, to withhold this discussion until the writer submitted his closure; the substance thereof is given below. The statement should have read as follows:

"The writer has always believed that, other conditions being equal, the evaporation will vary with a function of the difference in barometric pressure at the different points."

The writer based his opinion and belief on the fact that the boiling point of water lowers as the barometric pressure decreases, requiring a smaller application of heat to vaporize the water at higher elevations. It is true that the data published in the paper by Messrs. Duryea and Haehl are insufficient to establish this beyond question, but a platting of the data in Table 17 of that paper shows that the curve of evaporation relation coincides with that of barometric relation between the limiting elevations of 2 500 and 5 000 ft. As Dr. Fortier's experiments ranged from Elevation 4 500 to 14 500 ft., they are nearly all above those quoted by Messrs. Duryea and Haehl, so that it is possible that the relation may change at the higher elevations. The writer's confidence in the physical law quoted is such, however, that he would rather be inclined to study with care all the conditions attending the Fortier experiments in order to ascertain if there was not a possibility of other influences being strong enough to counteract that of elevation.

The specific correction for the influence of elevation on the rate of evaporation by comparison with the evaporation records in Owens Valley was made from a study of the figures in Table 20 showing the barometric differences, considering the barometric pressure at sea level as 30 in. of mercury.

TABLE 20.

Mr. Hammatt.

Elevation, in feet.	Barometric height, in inches.	Drop in barometer from sea level.	Percentage relation to barometric height at Elevation 3 775.
2 000	27.79	2.21	— 44.8
3 000	26.74	3.26	— 18.5
3 775	25.96	4.04	.....
4 000	25.74	4.26	+ 6.4
4 090	25.65	4.35	+ 8.6
4 410	25.34	4.66	+ 16.3
5 000	24.77	5.23	+ 30.6

The writer makes no claim that the various coefficients used in correlating the evaporation records at Independence to conditions existent on the Chewaucan Marsh are absolute. He maintains, however, that their principle is established by physical laws, and that their application is a matter of engineering judgment in connection with careful observation of field conditions. This is particularly true with the deduction for plant cover, characterized by Mr. Stevens as "mere guesswork." The physical law is that saturated air will take no additional water vapor, and must be replaced by dry air if evaporation continues. The fact, determined by the writer by inspection at various periods of growth, was that, as the grass grew higher and spread, the movement of air was more and more restricted. Although the straight-line variation may not be justified by experiment, it is by logic, until experiment shall have given a better one.

In this matter it is interesting to note the actual results of the soil pan evaporation tests in Harney County, as shown in Figs. 15 to 20, inclusive. These are tabulated in Table 21, from which it will be noted

TABLE 21.

Location.	Year.	Length of Season.			Evaporation loss, in inches.
		Begins.	Ends.	Days.	
Wickes Field	1915	April 8	July 13	96	12.10
Frye Field	1915	May 18	July 15	58	8.90
Verdo Field	1915	May 5	July 12	68	7.50
Wickes Field	1916	March 30	August 4	127	15.78
Frye Field	1916	April 13	August 4	114	15.62
Verdo Field	1916	March 28	August 3	128	17.33
Mean	.....	.....	.....	98.5	12.87

that, although the season averaged shorter than that assumed for the Chewaucan calculation, the total evaporation was greater. This may be explained by the fact that the season falls about a month later in the

Mr. Hammatt.

Harney County tests than in the Chewaucan calculation, a part of the hotter months—July and August—being included in place of March and April, used in the Chewaucan figures.

In Fig. 25 are platted the heights of the growth in the various pans in the Harney County tests during the season of 1916. The uniformity of growth is apparent from this diagram, justifying the straight-line reduction of evaporation for plant cover and the uniformity of transpiration increase.

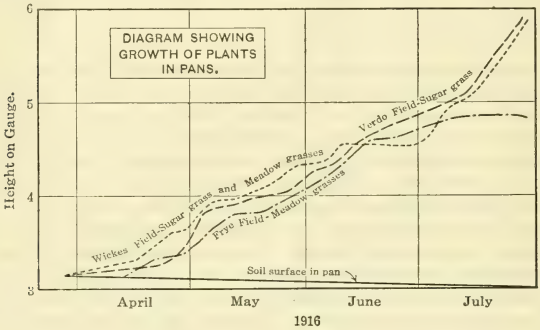

FIG. 25.

Mr. Stevens states that plants continue to use water after maturity, and compares the use of water by plants with the consumption of food by man, with a fine disregard for the laws of mechanics. The food consumed by man is transformed into mechanical energy, which is dissipated in work or motion. Plants perform no such work, and their food goes entirely into growth. When a plant reaches maturity, it ceases to take in water through its roots, and loses in drying a large portion of that already taken, making hay while still standing. There is even a claim of a slight backflow into the earth, causing the loss of some of the food value, for which reason it is considered advisable by stockmen to cut for hay slightly before maturity, though the writer is somewhat skeptical as to this, and believes that the greater food value of hay cured after cutting over that cured standing is probably due to other causes.

Mr. Stevens is evidently not familiar with the practice of curing hay. It is not usual to leave the hay on the ground more than 48 hours, and where possible it is stacked within 72 hours after cutting. Stockmen consider that the hay loses in food value if left longer without stacking. Moreover, after putting in the stack, it not only ceases to lose weight, but gains in weight by absorption from the atmosphere.

Mr. Hammatt.

Mr. Stevens' inference that the ratios of green weight, cured weight, etc., used in the Harney Valley experiments were taken from the test made at Chewaucan Marsh is also in error, the cutting from each of the pans having been cured for 48 hours and weighed at intervals during the period.

The writer, after considerable study, is unable to comprehend Mr. Stevens' "guessing" paragraph, so assumes that it was put in to add humor to his discussion.

Regarding the matter of soil absorption, Mr. Stevens' information is correct as to the nature of the peat, and also in regard to its low capillary limit. The layer of actual turfy peat, however, is quite thin, being from 8 to 12 in. in depth, followed by a mixture of peat in the white volcanic soil, described in the paper as underlying the marsh, and gradually changing to the unmixed white soil. Although the turfy peat has a low capillary limit, it shrinks and cracks in drying, allowing free access of air to the underlying soil, which has a much higher capillary limit. Test holes bored in September, 1916, two months after the discontinuance of irrigation, showed that the soil was practically dry for a depth of 2 ft. About thirty holes were bored at this time, representative of the entire area of the two marshes. As the subsoil has been found to be practically impervious, the contained water at the close of irrigation must have been lost by capillary rise and surface evaporation.

In the later test of the absorption capacity of the soil, Mr. Stevens correctly interpreted Fig. 23 as showing the putting of 13.54 in. of water into the tube on September 10th, 10.15 in. being introduced at 4.30 P. M. and 3.39 in. at 5.05 P. M. The top of the tube was covered, to prevent evaporation, and measurements of the lowering of the water surface were made at intervals thereafter. The curve above the line, showing the depth of water absorbed, was platted from the observations up to September 28th, the broken line being produced at the same rate, which had been uniform for the previous 2 weeks. The curve below the line, showing the depth of penetration of the absorbed water, was platted for the first 6 in. from tests taken previously, the final measurement being taken on September 28th, when the tube was removed and the core examined. The line between these points, as well as its dotted extension, was made from the percentage relation found from the measurements taken.

We now come to the interesting part of the discussion, the attempted application of run-off data at the three main gauging stations on the Chewaucan River to determine the actual consumption on the marsh. The arguments used remind one so strongly of those appearing in *Northwest News,* a promotion sheet published by the real estate firm promoting the Paisley Project, and the data presented have such a similarity to those presented by the engineer for that contestant in

Mr. Hammatt.

the litigation, that the reason for the rather acrimonious nature of Mr. Stevens' discussion may be inferred. In fairness, the records of the case should have been quoted, showing the presentation of data to the effect that, although the measurements at Hotchkiss Ford included all water running off the marsh, those at the Government gauging station did not include all that running on the marsh, that the water passing the Hotchkiss Ford gauge did not all pass the Narrows, and that passing the Narrows did not all pass the Government gauge. Testimony was presented showing a very considerable water-shed with a high run-off percentage tributary to the marsh, the run-off therefrom being intercepted by a drainage canal along the edge of the Upper Marsh and delivered at the Narrows, and along the edge of the Lower Marsh, to Hotchkiss Ford. A creek of considerable size, known as Moss, or Avery, Creek, empties on the Upper Marsh and is not included in any measurements given of inflow, while another, still larger, known as Willow Creek, is used for irrigation near the Lower Marsh, and was, by the breaking of dams, diverted into the Lower Marsh without appearing in any measurement except that of Hotchkiss Ford. The effect of these is very apparent by comparison of the daily hydrographs at the three stations, the run-off at Hotchkiss Ford often exceeding that at the Narrows during rainfall periods, and that at the Narrows increasing by a much greater percentage than that at the Government Station.

Since this paper was written, the Court has handed down a decision based on the evidence produced at the trial, allowing a duty of 3.9 ft., or 46.8 in., somewhat smaller than that claimed, but about double that advocated by Mr. Stevens. This decision has been upheld by the Supreme Court, an appeal having been denied. The difference between the duty claimed, 60.1 in. and that allowed by the Court, 46.8 in., or 13.3 in., was doubtless due to the Court's opinion that the full run-off claim of 23 in. was not indisputably established.

The writer acknowledges the impossibility of establishing the exact quantity necessary to insure the proper movement of water over the marsh, due to the irregular flow of the river. The total run-off measured at Hotchkiss Ford, shown in Table 19, certainly did not represent the necessary run-off, as a material part of it was run-off from the adjoining water-shed during storms, and did not go on the marsh at all. The actual necessity for the movement of the water is well established, however, an analysis of the plant growth on the marshes having been made by Professor P. B. Kennedy, of the University of California, and it being shown by survey that whenever the flow of the water was impeded by knolls or ridges, the valuable grasses were replaced by tules and cat-tails, and wherever the flooding was intermittent, as on the tops of knolls, covered during the periods of greatest flow but uncovered during periods of lesser flow, the predominant

Mr. Hammatt.

growth was blue-joint and fox-tail. As for Mr. Stevens' statement that if the claim of the necessity were true "there could scarcely have been any crop at all in 1915," he is quite right, there having been no crop at all on those parts of the marsh where the water ran on and was consumed without run-off, the only full crop being obtained from the small acreage at the head of each marsh, where the water was first turned on the land and kept running continuously over it. This point was also well established by testimony, and appears in the Court records.

A study of the hydrographs of the various years of record shows in general an excess of water during the early summer, with a falling below the requirement from the middle of May onward. By turning the whole flow over the land and flooding it to a depth greater than was actually needed, the water was held and the uncovering of the marsh delayed beyond the time when it would otherwise take place. It is this which causes the run-off percentage to be so high in some years. For instance, in 1914 there was a very high March and April flood, causing a high run-off for that year. In 1916, the flow of the water was ideal, coming at the exact time and in the quantities needed, causing a low run-off during the parts of the season when in general the run-off is high.

The writer asks the indulgence of his readers for having gone into so much detail in his closure on a paper which was intended—and so stated in the opening paragraphs—to be merely descriptive of methods used, for the purpose of drawing discussion and criticism of these methods, and tending toward improvement in future studies. It was not his intention to make any point of the results obtained, these being of merely local interest. This point is entirely missed or ignored by Mr. Stevens in his first discussion, in which he criticises the writer's failure to touch on the matter of efficiency.

The discussion, however, has enlarged the writer's knowledge by offering him additional food for thought, and enables him to draw the following conclusions:

(1).—That laboratory experiments are apt to lead to erroneous conclusions if the exact field conditions are not reproduced. This point was brought out by Mr. Harding. It was to satisfy this condition that the pan experiments in the Harney Valley tests were made in the fields themselves, instead of all together in one place, reproducing the same conditions as to plant cover and water depth in the pan as in the adjoining field. One pan of each set had a portion of the water removed and replaced from time to time, in order to reproduce as far as possible the condition of changing water due to flow on the land.

(2).—That there is a sparsity of evaporation data, and such records as there are lack sufficient completeness of detail to permit comparison.

Mr. Hammatt.

It would be advantageous if all the evaporation work could be conducted by either the Weather Bureau or the Geological Survey, in order to insure uniformity, the pans being run at the principal stations in combination with the other data, in order to have available for every section a record of evaporation as well as of rainfall, run-off, temperature, etc.

(3).—That subsoil losses can only be determined by field experiment on a large scale, and necessary surface run-off can only be determined by long-time observations of results under conditions as they exist

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THE ECONOMICS OF STEEL ARCH BRIDGES

Discussion.*

By J. A. L. Waddell, M. Am. Soc. C. E.†

Mr. Waddell.

J. A. L. Waddell,‡ M. Am. Soc. C. E. (by letter).§—The hearty thanks of the writer are tendered to all who have done him the honor of discussing his paper, and especially to Mr. Fowler for the many weeks of hard work which he devoted to the compilation of the table of data (Table 8, Plate III||) concerning one hundred long-span arch bridges. It is a matter of regret that there were not more contributors to the discussion, especially as so many were asked individually to take part therein. The reason for this, undoubtedly, is the very limited amount of knowledge in the Profession, previous to the publication of the paper, concerning the economic questions treated and the weights of metal in steel arch structures.

Of the eight primary economic problems set originally for solution in this paper, six were solved by making special designs and subsequent computations of weights of steel, thus settling, for these cases, beyond all doubt whatsoever, the question of economy of metal; but the other two were based on certain semi-rational, semi-empirical formulas that give the approximate weights of carbon steel in braced-arch ribs. In these problems the validity of the conclusions reached in the investigation was legitimately subject to question; and that question was raised by Mr. Fowler, who based his criticism mainly on averages of percentage functions taken from the very complete table of long-span arch bridges which he compiled.

* Discussion of the paper by J. A. L. Waddell, M. Am. Soc. C. E., continued from January, 1919, *Proceedings*.

† Author's closure.

‡ Kansas City, Mo.

§ Received by the Secretary, May 16th, 1919.

|| *Proceedings*, Am. Soc. C. E., August, 1918.

Mr. Waddell.

He showed that the writer's economic ratios of rise to span length for the different types of arches agree fairly well with the superior limits found. Possibly this is merely a fortunate coincidence, because designers are often prevented by ruling conditions from adopting what they might deem to be economic ratios of rise to span length; but, on the other hand, it might be considered by some as corroborative evidence of correctness.

In the other of the two problems, however, *viz.*, the economic depth of arch ribs, there is seldom any condition precedent which should prevent a designer from adopting approximately the most economic depth; and hence averages of depths of ribs of existing arches should show what the general impression of designers has been concerning this question of economics. Mr. Fowler computed these averages and found results considerably lower than those which the writer determined by the use of his before-mentioned formulas for weights of arch ribs. From individual judgment, based on these averages, and on the writer's findings as well, Mr. Fowler determined certain compromise economic depths varying from 2.5% for plate-girder arches to 4.0% (and in one case 4.3%) for lattice-ribbed arches. Instead of 4.0%, the writer had found 7.5% as the most economic depth, but had pointed out that a material variation can be made therefrom without greatly increasing the weight of metal in the arch, also that "any variation that is likely to be adopted will be a reduction; because, generally, the appearance of the arch is improved by making its rib depth smaller than the economic one." Computations made from Fig. 6 show that, on the basis of the writer's original investigation, decreasing the ratios of depth of arch rib to span length would give certain percentage increases in weights of metal in the ribs. These are shown in Table 12.

TABLE 12.

Ratio of depth of arch rib to to span length.	Percentage increase in weight of metal above minimum in arch rib.	Ratio of depth of arch rib to span length.	Percentage increase in weight of metal above minimum in arch rib.
0.75	0.00	0.55	2.75
0.70	0.20	0.50	4.20
0.65	0.65	0.45	6.80
0.60	1.30	0.40	10.50

In view of the preceding, it is evident that the writer, when proportioning an arch rib, would probably have adopted, for esthetic reasons, a depth equal to about 6% of the span length, notwithstanding the fact that he had shown the theoretically economic depth to be 7½% thereof.

Mr. Waddell.

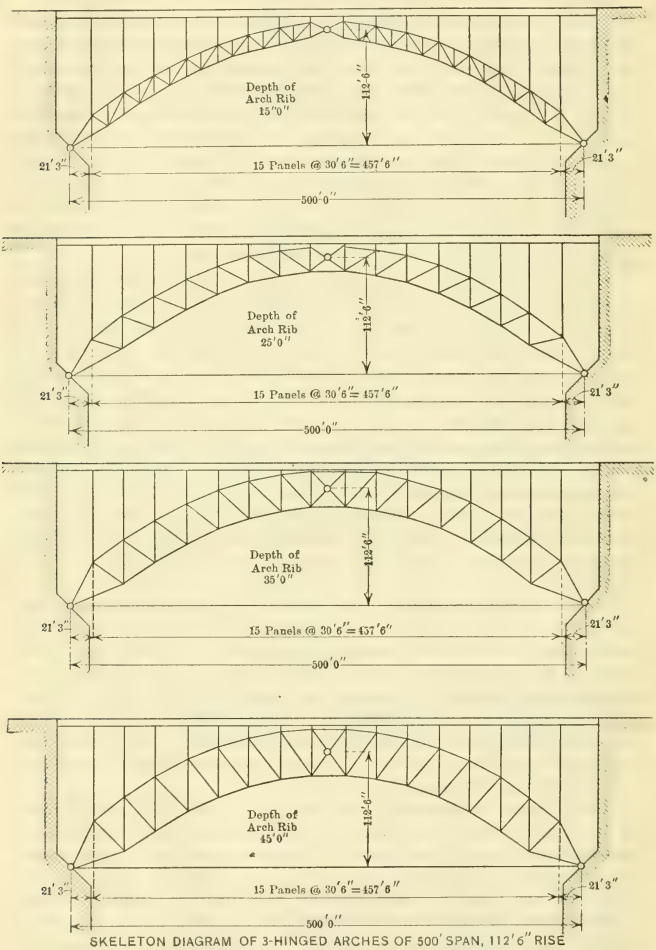
When Mr. Fowler challenged the findings of the investigation on this point, the writer stated that he would prepare four designs and estimates of weight for the ribs of a 500-ft. span, double-track railway, three-hinged arch bridge, so as to plot a curve indicating the actual economic depth; and he has since done so, the depths chosen for trial being 3, 5, 7, and 9% of the span length. These layouts are shown to scale on Fig. 32. The computations of stresses were made by the writer's Assistant Engineer, Mr. Francis De Schauensee, using the modern method of influence lines, but, in accordance with the writer's suggestion, checking one set of figures by the old established system of unit panel loadings. Although the check, of course, was not exact, it was sufficiently accurate for all practical purposes.

With these stress sheets as a basis, and using the designing specifications of "Bridge Engineering", the writer computed the sectional areas of all the main rib members and measured their lengths from the diagrams, reducing properly those of the web members to allow for their failure to reach the center lines of the chords. Then he multiplied each tabulated sectional area by the length of the piece, added the results, and multiplied the sum by 3.4, the product representing the weights of the main members, exclusive of the details. All the latter, in which the weights thereof are approximately alike for the four cases, such as stay-plates, connecting plates, diaphragms, hinges, and rivet heads, were omitted, but the weights of the splices and the lacing angles were computed and added in. The four quantities thus found were used as "comparing weights" to settle the economic question which was being investigated.

These "comparing weights" were plotted on Fig. 33, and a curve was drawn through the located points. Considerable thought was given to the drafting of this curve between the limits of 5% and 3% depths, owing to the abnormality of the latter layout. It would have been somewhat more accurate to compute the weight for a 4% depth, but the time and expense involved thereby did not appear to be justified. From this curve, it will be seen that the economic depth of the rib for this span and for railway loading is $6\frac{1}{2}\%$ of the span length, instead of $7\frac{1}{2}\%$ thereof, as previously determined.

Recognizing that the making of a corresponding set of calculations for a highway bridge would be a comparatively simple matter, all stresses being found by slide-rule, the writer concluded to investigate the correctness of his previous finding, *viz.*, that the economic rib depths are the same for both railway and highway bridges. Some *à priori* reasoning, based on the manner of variation of the governing adjusted total stresses, had led him to the conclusion that these economic depths would be less for highway arches than for railway arches, the factor of main influence being stress reversion in chords, which

Mr. Waddell.



SKELETON DIAGRAM OF 3-HINGED ARCHES OF 500′ SPAN, 112′6″ RISE

FIG. 32.

influence, of course, augments as the ratio of live load plus impact to total load increases. Mr. Waddell.

Estimates of "comparing weights" were made as before for depths of 3, 5, 7, and 9% of the span length, and the results were plotted on Fig. 34, from which it will be seen that the economic depth for this case is 5% of the span length.

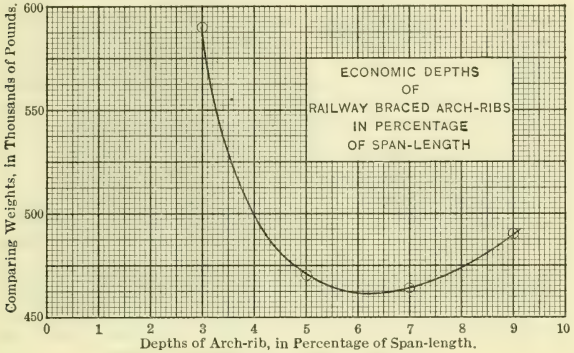


FIG. 33.

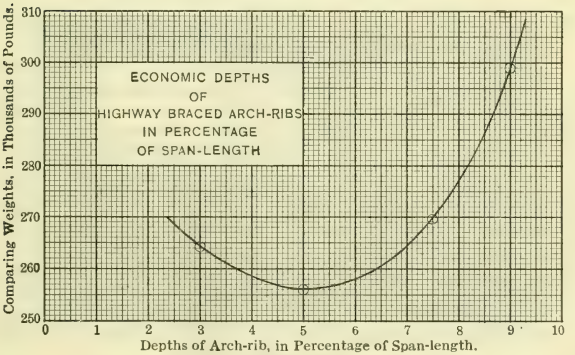


FIG. 34.

These two sets of figures permitted the determination of the manner of variation of the economic depth with the ratio of live load plus impact to total load, as shown on Fig. 35. The two points enclosed in circles on that diagram indicate the economic-depth ratios correspond-

Mr. Waddell.

ing to the ratios of live load plus impact to total load, in the case of railway and highway arch spans of 500 ft. By joining these points with a right line and extending this line in both directions, we obtain the data from which, by using Figs. 18 and 19, the diagram in Fig. 36

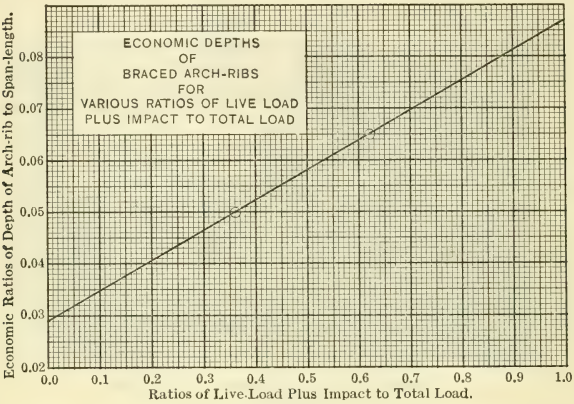


FIG. 35.

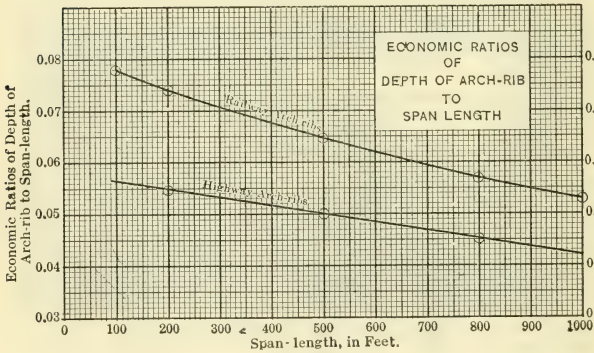


FIG. 36.

has been prepared. That diagram shows that the economic depth ratio for railway arch ribs varies from 0.078 for 100-ft. spans to 0.053 for 1 000-ft. spans; and for highway arch ribs from 0.056 for 100-ft. spans to 0.042 for 1 000-ft. spans.

Mr. Waddell.

These depths are greatly in excess of the 0.04 ratio established by Mr. Fowler; and the investigation proves that, in endeavoring to ascertain such important functions as economics, it is not safe to base one's conclusions on averages of professional practice. The writer feels greatly indebted to Mr. Fowler, not only for the good work which he has done in compiling his table of information concerning existing arch bridges and arch-bridge designs, but also for having challenged the writer's finding for economic depth of arch ribs. For railway arches the economic ratio first found proves to be all right for short spans, though too great for long ones; but the deduction made, to the effect that the economic-depth ratios are the same for both railway and highway bridges, is wrong. The reason for the occurrence of the error is that the weight formulas for arch bridges, which were adopted as a basis for the investigation, were of a too empirical character to warrant their use for the economic-rib-depth study, although sufficiently accurate for that of the economic ratio of rise to span length. The probable explanation of engineers' failures in the past to use economic depths when designing arch ribs is that they did not pay much attention to the question of economy when making their determinations.

As for the question of esthetics, the writer is of the opinion that a rib depth of 6% is more pleasing to the eye than a smaller one, and that such extremes as 3% or even 4% are unsightly. If a designer prefers the appearance obtained by using a 5% depth, he can generally obtain it in railway structures by the addition of 2 or 3% to the minimum weight of metal—certainly not a very serious extravagance.

The eight diagrams of stresses, sectional areas, and lengths of members, prepared in making this supplementary investigation, are not included in this résumé, but may be found in the files of the Society.

Mr. Fowler claims that greater ratios of rise to span length are necessary for heavy arch bridges than for light ones; because of the element of rigidity, and, therefore, he questions somewhat the writer's findings; but, concerning this claim, two facts should be borne in mind:

First.—The writer's investigations were made for economic depths, and, therefore, not necessarily for the best depths to adopt for all cases and all conditions; and

Second.—The economic ratios of rise to span length found by the writer are never small, varying as they do from 0.20 to 0.28 for solid-rib structures, being 0.25 for spandrel-braced structures, and lying between 0.225 and 0.38 for braced-rib structures. Mr. Fowler's table shows, for structures of these three classes, respectively, the following averages: 0.18, 0.197, and 0.202, as against 0.24, 0.25, and 0.3 by the writer. Mr. Fowler's corresponding recommended averages are, respectively, 0.22, 0.254, and 0.272.

From this it is seen, that by taking averages for these three groups of averages, *viz.*, 0.193, 0.263, and 0.249, the writer's economic ratios of

Mr. Waddell.

rise to span length, on the average, are 36% greater than those hitherto adopted by the Profession and 6% greater than those recommended by Mr. Fowler.

The reason that, in truss bridges, light structures, for economy of metal, require smaller truss depths than heavy ones is because of the greater values of $\frac{l}{r}$ in the web members; but, in arch bridges, this condition is cared for by varying the ratio of depth of arch ring to span length, and not by changing the ratio of rise to span length.

Dr. Thomson's suggestion that, in very heavy steel bridges, box sections for chords be used, is an excellent one; and the writer for years has been advocating this innovation. In making the plans for the Fratt Bridge, over the Missouri River, at Kansas City, he adopted the closed section; but the innovation was too drastic for the manufacturer, who was also the erector of the structure; and the plans were modified to agree with current practice, in order to comply with his wishes.

Mr. Farr asks why the writer, in Tables 4 and 6, gives the weight of metal per linear foot "per side" for ribs and lateral system, while in Table 5, he gives it in pounds per linear foot of structure. The answer is that, throughout the paper, comparisons were made by excluding all weights common to the structures compared, and hence the floor-system weights were generally omitted, and one side of the structure only was considered. In Table 5, however, it was desired to show the variations in the total weights of metal per linear foot in the three types of construction, consequently, that of the floor system was included in the totals.

When Mr. Farr says: "The economy in the weight of metal in the arch over the simple truss appears, from the information in the paper, to commence at spans of more than 1 000 ft., etc.", and "As it is only in the larger spans of more than 1 000 ft. that any economy in weight is shown over even a simple truss, and as the span at which the arch will come out lighter in weight than the continuous truss will be very much more than 1 000 ft., etc.," it is evident that he made a mistake in reading Fig. 16; for, in railroad bridges, the economy of the arch is shown to begin at spans of about 100 ft. and not at 1 000 ft., as he claims, and, in highway structures, the arch bridge is indicated as always being more economic of metal than the truss bridge. There is no good reason for this misinterpretation, because the title of Fig. 16 reads "Percentages to Apply to Weights of Metal in Trusses of Simple-Truss Spans in Order to Find the Weights for Arch Ribs and the Superimposed Columns with Their Bracing to Carry the Same Live Loads"; and there is no percentage recorded that is as great as 100.

Answering Mr. Van Cleve's remark that "To place a field splice across the crown-hinge would undoubtedly be possible, but, in the speaker's opinion, would rarely be justifiable, owing to the quantity of

Mr. Waddell.

splice metal required, and the expense of the field drilling", the writer would reply that this expedient has already been adopted, and without much trouble or expense. If the filling-in is done at an average temperature, the field work involved is very simple, but, at any other temperature, some special apparatus is required. The good results gained by the insertion of the additional members are worth many times the extra expense involved.

Answering Mr. Sales' remark that "Nevertheless, it is to be hoped that, judging by past experience, the author will find time to write a treatise on arch bridges, and include in it all the diagrams and preliminary work for which space could not be found in his paper", the writer would state that, some time ago, he arranged to do almost that very thing by writing jointly with a young engineer, who is expert on difficult mathematical work, a complete treatise on "The Designing of Steel Arch Bridges", the writer taking the chapters dealing with the economics, the specifications, and all the practical features, and his associate handling those involving the mathematics. The work had progressed only so far as the laying out of the list of chapters and the determination of the character of the contents of each, when, after thinking the matter over, the young man decided that he would not undertake the contemplated enterprise; hence it was abandoned. As the writer has neither the time nor the inclination to do, unaided, all the work on such a book, it will never be written by him, but must be left to some younger man, possibly working in conjunction with an experienced bridge designer and builder.

Mr. Sales asks what the writer means by "lateral system." The term includes all the bracing between adjacent trusses, ribs, or girders, whether lying in horizontal, vertical, or inclined planes; but excludes the cross-girders, which pertain to the "floor system." Mr. Sales is correct in his surmise that the writer assumed that "the weight of the lateral system plus rail-girders plus cross-girders will offset that in the bracing of the floor system, plus that of the rib flanges of the corresponding arch structure, plus that of the other diagonals between the arch ribs"; but the writer had indicated clearly that the weight of the vertical sway bracing between opposite columns was included with the weight of the said columns and the arch ribs, hence the word "other" excluded the diagonals of the vertical sway bracing.

The section in an arch rib will not often be "symmetrical about the neutral axis", for the areas of the chord members will generally be in direct proportion to the governing stress combinations. The contour of the arch rib usually cannot "be placed so as to give symmetrical rib sections"; but, for uniformly distributed loads, the axis (or line of apparent symmetry) is a parabola, while in other cases the curve should correspond to the equilibrium polygon for dead load plus one-half the live load.

Mr. Waddell.

Mr. Sales asks "what the author has to say" on the subject of the simultaneous existence of economy and esthetics in bridge design. More than two decades ago, the writer expressed himself thus:*

"The author is a firm believer in the principle that true economy, engineering excellence of construction, and the best architectural effect will almost invariably be found to accompany each other, and be inseparable in the designing of any bridge. Moreover, any bridge built with due consideration for, first, efficiency, second, appearance, and third, economy, will be satisfactory and gratifying to not only the trained expert, but also to the general engineer and the railroad man, and even to the public; because when an observer notes that in such a structure all the engineering requirements are properly provided for, that there is no evident waste of material, and that all due advantage has been taken of the conditions to render the bridge sightly and in harmony with its surroundings, his eye will of necessity be pleased, and his inherent sense of fitness will cause him to regard the structure with a feeling of pleasure."

Mr. Sales asks how the writer "would design the ordinary through type of truss span so that the top lateral bracing could be arranged to assist the top chords to the utmost extent by taking a part of the compression to which these members are subjected." The aiding of the top chords by the upper lateral struts is not a desirable feature, but, unfortunately, to a certain extent, it is unavoidable. In American practice such aid is reduced to a minimum by swinging the span clear from the falsework before making the final connection for each diagonal of the upper lateral system, thus preventing these diagonals from aiding at all in carrying the dead load. If it is considered advisable to reduce the amount of the aid which the diagonals give in resisting the live-load stresses in the chords, it can be done by putting a draw in them, or, in other words, by punching the connecting holes so as to shorten slightly the effective length of the piece and stretch it during erection by the use of drift-pins.

Answering Mr. Sales' question in respect to Problem No. 4, the comparisons were made with three-hinged arches; but the writer does not believe that the results would be any different for two-hinged arches. Hingeless construction for the spandrel-braced arch, although feasible under certain conditions, as far as the writer knows, has never been attempted or even considered. He can see no possible advantage in adopting it.

The writer is of the same opinion as Mr. Sales, concerning the economics of continuous trusses, *viz.*, that the economy claimed by some engineers is due simply to an improper ignoring of the effect of reversing stresses. He has had in mind lately the solution of this question in the only satisfactory way possible, namely, the proportioning of two continuous and two non-continuous trusses for the same layout

* In his little book "De Pontibus", p. 47.

and the same live load under different specifications in respect to the treatment of reversing stresses. Owing to the fact that the calculation of stresses in long-span, continuous trusses is tedious, complicated, and expensive, the writer thought to shorten greatly the labor involved in his proposed economic investigation by procuring from a brother engineer the live-load stresses, dead-load stresses, weights of metal, etc., for a large two-span structure with continuous trusses, which that engineer had lately built; but the favor was refused. Some day, however, if the writer lives long enough, he will solve this and two other economic problems; because these three would about complete the solution by him of all the important economic questions that occur in the specialty of bridge designing. Mr. Waddell.

In respect to the diagram on Fig. 16, concerning which Mr. Sales states that the writer computed the percentages for only the 100-ft. and 1 000-ft. spans and interpolated for all intermediate spans, there is a misunderstanding. The lines for both railway and highway structures were determined for a number of spans. It was the intermediate line for electric railway structures that was interpolated, owing to the fact that the writer has not built many electric railway bridges that do not carry also highway loads.

The writer certainly appreciates highly the trouble which Professor Jacoby took in preparing so much valuable information concerning metallic arch bridges to supplement his paper.

Mr. Molitor must have overlooked the last six lines of the penultimate paragraph of the paper, which read thus:

"Again, the comparison of the costs of arch superstructures and truss superstructures alone is not of much importance; for an economic investigation, to be of any value, must include both substructure and superstructure; and the costs of the former are likely to be very different in arch designs and simple-truss designs for any crossing."

It is impracticable to take the substructure into account when making general economic investigations for arch bridges, because no two case thereof are alike. In case of a succession of long spans in which there is a choice of rise, a tentative layout should be made, using the anticipated economic ratio of rise to span length when both substructure and superstructure costs are considered, then the cost of piers and spans should be computed, the uneconomic effect of departing from the established economic ratio of rise to span length given in Figs. 1 to 4, inclusive, being used to calculate the weights of metal from those diagrammed in Figs. 17 to 21, inclusive. Next, this work should be repeated for a slightly greater ratio of rise to span length, and then for a slightly smaller ratio thereof. These three sets of computations would probably determine the best ratio; but, if not, still another set of calculations would be necessary.

Mr. Waddell.

Mr. Molitor criticizes the writer's statement that "in order to cover effectively the ordinary range of span lengths for arch designing, it was necessary to compute for three lengths", saying that "it requires more than three points to fix a curve or law." In reply, the writer would state that the results of the calculations on these span lengths were not used to plot curves, but merely to show how the economics varied for different span lengths. An ample number of points was used in locating all the curves given in the paper.

Concerning Mr. Molitor's remarks on Problem No. 2, the questions he brings up are fully treated in the résumé on Mr. Fowler's discussion; but the writer would also remark that the fundamental principle of the method he originally used in determining the economic ratio of depth of rib to span length was logical, although not quite accurate enough, as was shown by the subsequently prepared, correct, detailed calculations, given previously in this closure.

Mr. Molitor thinks that "it is strange that the author did not give more attention to the economic shape of the arch center line." The reason therefor is that this economic question had already been solved satisfactorily by other investigators, including Mr. Molitor himself, the scope of the paper being only economic problems hitherto unsolved or incorrectly solved. Reference was made to this matter at one place in the paper, where it was stated that, if the dead load is practically uniform across the span, the curve should be a parabola; and that, otherwise, it should correspond to the equilibrium polygon for dead load plus half the live load.

The assumption by the writer of a single value for impact for all arch spans of the same length and subject to the same live load caused no error of any importance in the economic deductions, for the small resultant errors in the several spans compared were practically alike. Without having made a number of assumptions similar to this in unimportance, it would have been impracticable for the writer to undertake the heavy load of work involved by the entire economic investigation.

That there should be a difference in arch bridges and truss bridges, as regards the treatment of the effects of reversing stresses, the writer is not disposed to deny; for he once was compelled to design a 425-ft. arch-span railroad bridge for British Columbia according to the awkward and, in many respects, absurd specifications for railroad bridges issued as standard for Canada by the Dominion Government. The writer determined first by his own specifications that the arch structure would be cheaper than a truss bridge; but, afterward, when it was detailed according to the rulings of the government specifications, the economics were reversed; nevertheless, for several good and sufficient reasons, the arch type of construction was finally adopted. Notwithstanding this fact, the writer cannot agree with Mr. Molitor in his statement that "all that can reasonably be required is to design

Mr. Waddell.

each member so that it will withstand safely its maximum and minimum conditions of stress, one at a time, without exceeding the allowable units of stress for each condition." Such complete ignoring of stress reversion does not appear to the writer to be warranted by the present professional knowledge concerning the wearing effects of reversing stresses.

Why Mr. Molitor pins his faith to Professor Howe's ancient findings concerning the comparative economics of hingeless, two-hinged, and three-hinged arches, notwithstanding the fact that the writer has lately found, from actually computed designs and weight estimates, diametrically opposite results to those of Professor Howe, is not apparent.

No, the writer certainly is not swinging over to an approval of the use of redundant members in bridge designing; nor does anything in the paper warrant the drawing of such a conclusion.

Replying to Mr. Stoney's statement that the arch bridge is not suitable for India, because the bridges in that country are generally over sand and silt river beds, requiring very deep foundations, the writer would reply that, for such crossings, the arch is absolutely unsuitable; but, when the mountain districts of that country are developed by railroads and highways, the arch type of structure may be found to be appropriate for many proposed crossings of streams and gulches.

Supplementing Mr. Frankland's remarks on the economics of the cantilever arch, the writer would point out that the reduction of the horizontal thrusts at the tops of the piers effects a decided saving in the cost of the latter; and that the greater the proportionate lengths of the flanking spans to the arch spans, the greater the economy in pier material. As before indicated, it is impracticable, in a general study of bridge economics, to take into account the variation in costs of substructures. One could do it by passing from the general to the particular, assuming a foundation profile; but the results deduced would apply numerically to only the crossing assumed. However, they would give a fair indication of what one might properly expect from other crossing conditions not too dissimilar.

In the case cited by Mr. Frankland, concerning the foundations of an arch bridge being partly rock and partly piles driven to rock, his solution of the problem is perfectly proper, because the bascule separates the two types of foundation; but, as he states, the placing of one abutment of an arch span on rock and the other on piles is an unwise expedient. In the writer's opinion, so doing might, under certain conditions, involve a violation of good engineering practice.

Some engineers, who adhere to old-fashioned notions, contend that masonry or concrete arch bridges are applicable to bed-rock foundations only, and that the piers and abutments therefor should never rest on

Mr. Waddell.

piles. Although it is true that bed-rock is the ideal foundation for such structures, pile foundations can be made entirely satisfactory, provided the masonry of the bases is carried well down into firm material capable of resisting properly the horizontal thrust. It is not legitimate to count on the horizontal resistance of the piles; and it would be criminal practice to rest the piers and abutments of an arch bridge on piles the tops of which, below the pier bases, act like stilts because of passing through soft material before reaching a hard bearing.

The writer was once the sole cause of the prevention of the building of an exceedingly long, reinforced concrete, combined railway and highway arch bridge over an arm of the sea where a great and disastrous wash-out had taken place, and in the design for which the bases of the piers and abutments were carried a very short distance below extreme low-water mark, and were supported by piles passing through 10 or 12 ft. of extremely soft material before reaching a layer of earth that had any claim to firmness. How much horizontal resistance could such stilts have offered to thrust produced by the passing of heavy locomotives? Had the structure been built on the proposed layout, an appalling accident, probably involving the loss of many human lives, would certainly have resulted; and it was only by the exertion of the writer's utmost powers of eloquence that the authorities were persuaded to reject the design. In fact, something more effective than eloquence was used; for the ignoring of a prediction of dire disaster by an acknowledged authority on bridge design would have rendered the officials concerned criminally liable in case of the occurrence of the predicted failure—and they were informed of that fact. As the writer was not retained on the work, and knew that he was not going to be, his motives were entirely altruistic; and he now has the satisfaction of feeling that the vigorous stand which he took saved the railroad companies and the community from serious trouble and the Engineering Profession in America from a lasting disgrace.

Mr. Frankland is quite right when he states, in respect to arch designing, that "the proper determination of the true economics calls for more judgment on the part of the designing engineer than with any other type of bridge"; and the writer trusts that the result of this paper, with the discussions and the résumé thereof, will be to enable those engineers who are considering the adoption of the arch type of construction for any crossing to come quickly to correct conclusions concerning the economics involved.

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PAPERS AND DISCUSSIONS

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IMPROVING ARCH ACTION IN ARCH DAMS

Discussion.*

By L. R. Jorgensen, M. Am. Soc. C. E.†

Mr. Jorgensen.

L. R. Jorgensen,‡ M. Am. Soc. C. E. (by letter).§—Both Mr. Creager and Mr. Woodard have made the suggestion that narrow gaps, say, 12 in. wide, should be left for contraction joints which should be filled during the cold season, before the pond rises.

It is true that such a wide crack could be filled more uniformly over 100% of the bearing, than one only $\frac{1}{4}$ to $\frac{3}{8}$ in. wide, but it requires twice the quantity of formwork to make this wide crack than to make the ordinary contraction joint. The cost of this extra formwork is considerably more than the cost of iron pipes for grouting purposes.

The grouting process does not take long to complete, and the richer grout will attain a high compressive strength in a short time, making it possible for the structure to withstand full water pressure very soon after grouting.

Mr. Woodard points out that, unless extraordinary care is taken, it will never be known whether or not the joint has been filled uniformly with grout. This, of course, is true.

The idea of the grout-pipe system has been developed largely from observations of how not to do grouting. The iron pipes are absolutely necessary, in order to be reasonably sure that too much area is not left without bearing.

One cannot be sure that the bearing of the contraction joint is 100%, but a water-tight joint can be obtained with less, as the voids would not necessarily connect with one another.

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* Discussion of the paper by L. R. Jorgensen, M. Am. Soc. C. E., continued from November, 1918, *Proceedings*.

† Author's closure.

‡ San Francisco, Cal.

§ Received by the Secretary, June 11th, 1919.

Mr. Jorgensen.

Arch stresses are generally kept low enough so that an accidental higher bearing stress can be taken care of with perfect safety. The material composing the ¼-in. inserted "key-stone" is well supported, and, therefore, can carry safely a higher stress than ordinary arch compression.

Mr. Nimmo's curves, shown in Fig. 11, correspond fairly well with what one would expect under the varying conditions of temperature and load.

The deflection of the crown of the Lake Spaulding Dam has been measured, from time to time, at a point 32 ft. down from the crest of the present dam (260 ft. above river level and 280 ft. above bed-rock), and at the crest.

The deformation of the concrete at the crest is more subject to variation of the temperature of the air, than at the point 32 ft. down, where the arch is thicker, which is only logical.

After the Lake Spaulding Dam was built to a height of 225 ft. above river level, in 1913, at a rather high rate of speed, the zero point for the deflection at the crest was set on November 25th, with the reservoir practically empty, but with all the chemical heat still in the concrete.

Three months later, the reservoir was full, and the cold water and air (February) had absorbed all or most of the chemical heat. The total deformation, due to the water load, the disappearance of the chemical heat, and the natural shrinkage, was 3.44 in.

The chemical heat had evidently caused the crown to be pushed in an up-stream direction about 2½ in., as the maximum deflection since has been less than 1 in. In 1916, 35 ft. were added to the top, and, at present, 15 ft. additional are being constructed.

During the last two winters, the contraction joints have been grouted with the exception of two. This grouting has had the effect of diminishing the deflection, which it should, and, on July 8th, 1919, with the reservoir practically full, the point 32 ft. below the crest deflected only $\frac{3}{16}$ in., and the one at the crest only $\frac{1}{16}$ in., this latter point being more subject to the higher temperature in July.

The water load generally comes on in the spring, at the same time as the increase in temperature. It can be expected, when the two remaining ungrouted contraction joints are filled, that, under the conditions stated previously, there will be no deflection, in which case the arch would act as a theoretical arch, with no secondary or cantilever stresses.

Should the reservoir happen to be full in the winter, there would still be some deflection, as then the deformation due to load would not be compensated by expansion due to increase in temperature; in fact, thermostats show a yearly variation of 20° Fahr. inside the dam, 24 ft. down from the 260-ft. crest, but the deflection would be less than if no grouting of the contraction joints had been done.

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ON A NEW PRINCIPLE IN THE THEORY OF STRUCTURES

Discussion.*

By G. A. Maney, Esq.

Mr. Maney.

G. A. Maney,† Esq. (by letter).‡—The writer submits the following discussion on the "slope-deflection" method§ as applied to frame analysis:

A difficulty in the analysis of frames for concrete ships is found in the irregularity in their make-up and the inapplicability of ordinary methods to secure accurate results.

The transverse framing of a concrete ship consists generally of a large number of members, of varying stiffness, connected by rigid joints, and continuous throughout. Many of these members have great variation in stiffness throughout their length, others are curved, and still others are arches in their mode of action, and vary as to loading and end conditions.

Perhaps the most unusual problem is that of a rigid frame having one or more of its members as irregular arches, with ends neither fixed nor free, but subjected to a degree of restraint determined entirely by the relative stiffness and loading of all the members of the structure.

In treating this problem, the method developed by the writer is similar to that described by Professor Swain in that the tangent

* Discussion of the paper by George F. Swain, Past-President, Am. Soc. C. E., continued from March, 1919, *Proceedings*.

† Senior Structural Engineer, Engineering Section, Emergency Fleet Corporation, Philadelphia, Pa.

‡ Received by the Secretary, May 2d, 1919.

§ The so-called slope-deflection method, as first treated by the writer, was published in "Studies in Engineering, No. 1" of the University of Minnesota, in 1915. A special application of this method was made shortly afterward in *Bulletin No. 80*, of the University of Illinois Engineering Experiment Station, in a paper on "Wind Stresses in Office Buildings." On p. 412 of the "Concrete Engineers' Handbook", by Messrs. Hool and Johnson, credit is given to the writer for the method for the general treatment of rigid frames, which is used in Chapter 10, on "Moments in Rigid Building Frames."

Mr. Maney.

direction or slope of the elastic curve of the member, at certain critical points, is used as a medium.

Discussion and Derivation of Method.—The end conditions of any member subjected to any possible distortion (in one plane) due to flexure, may be expressed or defined by certain functions of the elastic curve which will be called S_A, S_B, R_v, and R_H. Each of these quantities, as used in the calculations, is some multiple of the tangent values of small angles. The angles, in turn (or their tangents), are measured by the quotients of certain deflections divided by distances on the member in question.

Any condition of distortion, as determined by these end conditions in combination with certain loads applied between the ends of the member, can be effected by the application of certain end moments, M_A and M_B, together with a force, F, at one end, applied in the direction of the line, AB, connecting the ends. The general expression for the bending moment, M, at any section, for the most general case of a curved member with flexure in the plane of the member only, takes the following form:

$$M = a\,M_B + b\,M_A + r\,F\,r + M' \ldots\ldots\ldots\ldots\ldots (1)$$

The quantities, a, b, r, v, and M' will be defined with the aid of Fig. 29.

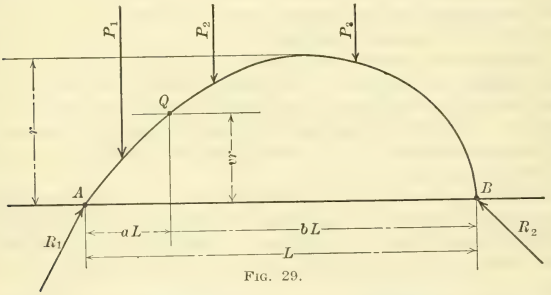


FIG. 29.

a is a ratio of the distance from A to the projection of any point, Q, on the line, AB, connecting the ends of the member, divided by the length of AB;

b is this ratio where the distance to the projection of any point is measured from B;

r is the rise, or distance, measured at right angles, from AB to the point on the axis of a curved member which is farthest from AB;

v is the ratio of this same distance for any other point to the distance, r;

M' is the bending moment at any point which is calculated on any statically determinate basis.

Mr. Maney.

In general, M' is assumed to be zero at the ends of the member. Then, any direction of one reaction (as R_1) is assumed, and its value is calculated by taking moments of the forces about B and equating to zero. R_2 may then be determined, both as to value and direction. The member now being in equilibrium under applied loads, the value of M' for all the points along the axis (ten are generally sufficient) may be calculated. It becomes evident that any set of M' values consistent with the applied loads may be used.

In order to make these end conditions of the elastic curve of the general member the unknowns to be solved for, rather than the unknown bending moments and thrusts at the ends, it becomes necessary to express the latter (M_A, M_B, and $F\,r$) in terms of the former (S_A, S_B, R_v, and R_H).

This can be done because of the definite and well-recognized relations between the extreme fiber deformations of a member subjected to bending, and the accompanying deflections.

Before this is done, a more definite statement concerning S_A, S_B, R_v, and R_H, will be made. These quantities are all ratios which, when multiplied by L (for S_A, S_B, and R_v) or by r (for R_H), will give certain multiples of deflection values. The deflections, $S_A\,L$, $S_B\,L$, and $R_v\,L$, are all measured in a direction at right angles to the line, $A\,B$.

The deflection of the end, A, from a tangent to the elastic curve at B, and in a direction at right angles to $A\,B$, is equal to $R_v\,L$, or $S_B\,L$, or a combination of the two, depending on the final direction of the line between the ends relative to its initial direction. In the general formula, this deflection must be made a function of both R_v and S_B. Also, the deflection of the end, B, from a tangent to the elastic curve at the end, A, will be a function of both R_v and S_A. The deflection of either end with respect to the other, which takes place in a line between these, is measured by the quantity, R_H.

To the foregoing deflections, are equated their values, in terms of the bending moment at any section. As before indicated, this moment value will be a function of the unknown moments, M_A, M_B, and $F\,r$, which are the values to be found as a result of a solution by this method.

The member under consideration will be divided into ten or more sections, having no necessary relation to each other, as far as relative length and stiffness is concerned. The value of $\frac{l}{I}$ for each section is obtained, l being the axial length of the section and I the average moment of inertia. The calculation of the values of $\frac{l}{I}$ is simplified by the consideration that only relative values of these quantities need be used.

Mr. Maney.

By means of the relation between the deformation of the extreme fibers in a bending member and its deflections, the value of these deflections will be expressed in terms of the bending moments which determine extreme fiber unit deformations.

Consider any small length, l, along the axis of any member subjected to bending stress, over which M is the average bending moment and I is the average moment of inertia. Applying the fundamentals of deflection, it will be found that $\sum_B^A b\,L\left(\frac{M\,l}{E\,I}\right)$ equals the deflection of the end, B, from a tangent to the member at A, and in a direction at right angles to $A\,B$. Therefore:

$$b\,L\left(\frac{M\,l}{E\,I}\right) = R_v\,L - S_A\,L.$$

$$\text{Likewise } a\,L\left(\frac{M\,l}{E\,I}\right) = S_B\,L - R_v\,L;$$

$$\text{and } v\,r\left(\frac{M\,l}{E\,I}\right) = R_H\,r.$$

Then, neglecting the value of E, which is common to all the equations, and knowing that only relative values of $\frac{l}{I}$ are necessary, the simpler form of these three fundamental equations of deflection are obtained:

$$b\,M\left(\frac{l}{I}\right) = R_v - S_A \quad \ldots\ldots(2)$$

$$a\,M\left(\frac{l}{I}\right) = S_B - R_v \quad \ldots\ldots(3)$$

$$v\,M\left(\frac{l}{I}\right) = R_H \quad \ldots\ldots(4)$$

In these equations it is necessary to govern the signs of the $\left[b\,M\,\frac{l}{I}\,(\text{etc.})\right]$ quantities by one method, and the signs of S and R by an entirely different scheme.

Also, the general frame problem must be divided into two entirely different phases. In one of these the object is to determine the effect of end conditions and loads on a curved member of varying stiffness, with regard to the distribution of moments throughout the length of the member. The common problem of the hingeless reinforced concrete arch is one of the simple forms of this problem, where the quantities, S and R, which determine the end conditions, are zero. In a problem of this sort, the bending moment at any section of a member will be considered as plus or minus, according as it produces tension on the

Mr. Maney.

lower or upper extreme fiber. Lower or upper extreme fibers may be determined entirely by a separate sketch of the member in any position, without relation to its exact relative position or orientation in the structure.

After finding the effect of all possible end conditions and applied loads on the end moments of this member, M_A and M_B, the sign of each of these moments is determined by its effect on the rotation of the joint in the structure to which it is adjacent. If it tends to rotate the joint clockwise it will be given a plus sign, and if counter-clockwise, a minus sign.

In any straight member, an individual solution to find the effect of applied loads and end conditions is not necessary. The moment at any end, A, of a straight member, AB, with uniform stiffness may be expressed in the general form:

$$M_A = M_{F_A} + \frac{2\,E\,I}{L}\,(3\,R_v - 2\,S_A - S_B) \ldots\ldots\ldots (5)$$

M_{F_A} is the fixed beam moment at A which gives the effect of applied loads when the end conditions are zero. This case is that of a fixed beam for a straight member, or a hingeless arch for a curved member.

For any end conditions other than those expressed by zero values of R and S, the effect of end slope values, S_A and S_B, and the relative end deflection, R_v, on the final moment, M_A, may be obtained by a direct algebraic addition of the end moments due to these quantities, to M_F.

It should be noted that the values of these end conditions, S and R, are determined entirely with reference to the original direction of the line connecting the ends of the member in its unstrained conditions.

Also, a clockwise rotation of the end slope values of the elastic line will make S_A and S_B plus, and a counter-clockwise rotation, minus. Similarly, if either end rotates in a clockwise direction relative to the other end, R_v will be plus.

When the general expression for M, as given by Equation (1), is substituted in Equations (2), (3), and (4), the following equations are obtained, and these, when solved simultaneously, will give perfectly general values for M_A and M_B, as well as $F\,r$. This last quantity measures the effect of end thrust in the direction, AB, on all the moments, and it will readily be seen that in any straight member this will not affect the moments in any primary sense:

$$\Sigma\, b\,\frac{l}{I}\,(b\,M_A + a\,M_B + v\,F\,r) = -\,S_A + R_v - \Sigma\, b\,\frac{l}{I}\,M'$$

$$\Sigma\, a\,\frac{l}{I}\,(b\,M_A + a\,M_B + v\,F\,r) = -\,R_v + S_B - \Sigma\, a\,\frac{l}{I}\,M'$$

$$\Sigma\, v\,\frac{l}{I}\,(b\,M_A + a\,M_B + v\,F\,r) = +\,R_H \qquad - \Sigma\, v\,\frac{l}{I}\,M'$$

Solving these three equations simultaneously gives:

$$M_A = -\frac{K_1 S_A - K_2 S_B + (K_1 + K_2) R_v - K_3 R_H + K_2 \Sigma a \frac{l}{I} M' - K_1 \Sigma b \frac{l}{I} M' + K_3 \Sigma v \frac{l}{I} M'}{K_1 \Sigma b^2 \frac{l}{I} - K_2 \Sigma a b \frac{l}{I} - K_3 \Sigma b v \frac{l}{I}}$$

$$M_B = +\frac{K_2 S_A + K_4 S_B - (K_2 + K_4) R_v - K_5 R_H - K_4 \Sigma a \frac{l}{I} M' + K_2 \Sigma b \frac{l}{I} M' + K_5 \Sigma v \frac{l}{I} M'}{\text{(Same denominator as for } M_A\text{)}}$$

$$Fr = +\frac{K_3 S_A - K_5 S_B - (K_3 - K_5) R_v + K_6 R_H + K_5 \Sigma a \frac{l}{I} M' + K_3 \Sigma b \frac{l}{I} M' - K_6 \Sigma v \frac{l}{I} M'}{\text{(Same denominator as for } M_A\text{)}}$$

$$K_1 = \left(a^2 \frac{l}{I}\right)\left(v^2 \frac{l}{I}\right) - \left(a v \frac{l}{I}\right)^2 \qquad K_4 = \left(b^2 \frac{l}{I}\right)\left(v^2 \frac{l}{I}\right) - \left(b v \frac{l}{I}\right)^2$$

$$K_2 = \left(a b \frac{l}{I}\right)\left(v^2 \frac{l}{I}\right) - \left(a v \frac{l}{I}\right)\left(b v \frac{l}{I}\right) \qquad K_5 = \left(b^2 \frac{l}{I}\right)\left(a v \frac{l}{I}\right) - \left(a b \frac{l}{I}\right)\left(b v \frac{l}{I}\right)$$

$$K_3 = \left(a^2 \frac{l}{I}\right)\left(b v \frac{l}{I}\right) - \left(a b \frac{l}{I}\right)\left(a v \frac{l}{I}\right) \qquad K_6 = \left(a^2 \frac{l}{I}\right)\left(b^2 \frac{l}{I}\right) - \left(a b \frac{l}{I}\right)^2$$

(NOTE.—All quantities, such as $\left(a^2 \frac{l}{I}\right)$, etc., mean $\Sigma a^2 \frac{l}{I}$.)

These summations may be obtained conveniently by the tabulated form indicated in the problem, and, in any case, are known functions of the shape (a, b, and v), the distribution of stiffnesses, $\frac{l}{I}$, and the loading, M'.

Mr. Maney.

Mr. Maney.

The following application of this method to a typical ship frame problem has been worked out by R. A. Cummings, Jr., Jun. Am. Soc. C. E. This problem considers the member around the bilge as an arch, with its end tangents free to turn a certain distance depending on the stiffness of the other members framing into it, as well as on the applied loads. It was simplified by the assumption of uniform stiffness throughout the length of the arch axis, and also by the fact that, although the ends here are free to twist, they will not have relative motion. These facts eliminate $\frac{l}{I}$ as a factor in the arch solution, and also eliminate R as an unknown to be solved for in the simultaneous equations. The four unknowns, S_B, S_C, S_D, and S_E, are obtained by the solution of four simultaneous equations for the joints of the frame, B, C, D, and E, respectively. Each of these equations expresses the statically determinate condition, that the summation of the tendencies of all the moments acting on a joint must equal zero.

Fig. 30 shows a diagram indicating the clear or effective span of the members, and Table 3 gives the calculation of the end bending moments of all the members for the condition where all the values of S are zero, which is the fixed-beam moment for the straight members and the hingeless-arch end moments for the arch member, AB.

In Fig. 30, for the lengths of members takes the clear span and not the distance from center to center of the supports.

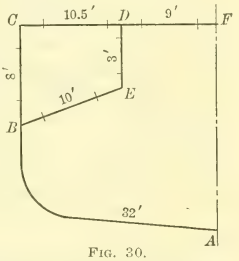


FIG. 30.

Find $\frac{I}{l}$ for all members, and express K in terms of $A\,B$, equal to 10,

$$\frac{I}{l} = \frac{d^3}{l} = K$$

$K_{AB} = 10$	$K_{CD} = 3$
$K_{BC} = 4$	$K_{DE} = 10$
$K_{BE} = 3$	$K_{DF} = 4$

Table 4 contains the complete general expression for the bending moment at each end of every member in the frame. Each of these moments takes the form

$$M_{1-2} = M_F + K\,(3\,R - 2\,S_1 - S_2).$$

M_F, the fixed-beam moment for zero change in end tangent direction, has been calculated, and R has a zero value in these equations, because the action of the frame admits of no relative displacement of the joints. K is a measure of the relative stiffnesses of the various members.

Mr. Maney.

TABLE 3.—CALCULATION OF FIXED-BEAM END MOMENTS.

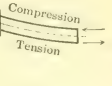
Point.	Member.	Loading.	Sign.	Moment.	Moment Value, in Inch-Pounds.
A	*AB*		+	From Previous Arch Solution.	3 527 000
B	*BA*		−	" " " "	116 000
B	*BC*		+	$M = \frac{W\,l}{10} = \frac{15\,600 \times 8 \times 12}{10}$	150 000
B	*BE*	None			
C	*CB*		−	$M = \frac{W\,l}{15} = \frac{15\,600 \times 8 \times 12}{15}$	100 000
C	*CD*		+	$M = \frac{w\,l^2}{12} = \frac{2\,000 \times 10.5 \times 10.5 \times 12}{12}$	220 000
D	*DC*		−	" " "	220 000
D	*DE*	None			
D	*DF*		+	$M = \frac{w\,l^2}{12} = \frac{2\,000 \times 9 \times 9 \times 12}{12}$	162 000
E	*EB*	None			
E	*ED*	None			

TABLE 4.—STIFF FRAME CONTAINING AN ARCH MEMBER.

Joint.	Member Equation.
B	$M_{BA} = -116\,000 - 10\,(4.50\,S_B - 0.71\,S_A)$. S_A = zero.
	$M_{BC} = +150\,000 + 4\,(-2\,S_B - S_C)$
	$M_{BE} = 0 + 3\,(-2\,S_B - S_E)$
C	$M_{CB} = -100\,000 + 4\,(-2\,S_C - S_B)$
	$M_{CD} = +220\,000 + 3\,(-2\,S_C - S_D)$
D	$M_{DC} = -220\,000 + 3\,(-2\,S_D - S_C)$
	$M_{DF} = +162\,000 + 4\,(-2\,S_D - S_F)$. S_F = zero.
	$M_{DE} = 0 + 10\,(-2\,S_D - S_E)$
E	$M_{ED} = 0 + 10\,(-2\,S_E - S_D)$
	$M_{EB} = 0 + 3\,(-2\,S_E - S_B)$

Mr. Maney.

In the member, BA, the end moment, M_{BA}, with zero change of slope, has an arch moment of — 116 000 in-lb. This was calculated in the example under arches. The arch moment sign, as calculated, is negative, which means that the outside arch fibers are tensile. To cause tension on the outside, that portion of the arch near the abutment, B, must rotate counter-clockwise, hence the negative slope deflection sign.



The four simultaneous equations necessary for a solution of a stiff frame containing an arch member are indicated in Table 5. Each of these equations states that the summation of the moments at the ends of all members framing into a joint, which occur at the joint, should equal zero. There are as many unknowns to be found (S_B, S_C, S_D, and S_E) as there are equations.

TABLE 5.—Stiff Frame Containing an Arch Member.

Sum up All End Moments Around each Joint and Arrange as Follows, Solving the Simultaneous Equations by Elimination:

	S_B	S_C	S_D	S_E	Constant 1 000 in-lb.
Joint B	+ 59	+ 4	.....	+ 3	+ 34
" C	+ 4	+ 14	+ 3	.....	+ 120
" D	....	+ 3	+ 34	+ 10	— 58
" E	+ 3	.....	+ 10	+ 26	0
①	+ 1	+ 0.068	.....	+ 0.051	+ 0.576
②	— 1	— 3.500	— 0.750	.....	— 30.000
④	— 1	.....	— 3.333	— 8.667	0
1′ + 2′ or ⑤′	....	— 3.432	— 0.750	+ 0.051	— 29.424
1′ + 4′ or ⑥′	....	+ 0.068	— 3.333	— 8.616	+ 0.576
⑤′	....	— 1.000	— 0.218	+ 0.015	— 8.573
⑥′	....	+ 1.000	— 49.015	— 126.706	+ 8.471
③′	....	+ 1.000	+ 11.333	+ 3.333	— 19.333
5′ + 6′ or ⑦′	....	.....	— 49.233	— 126.691	— 0.102
5′ + 3′ or ⑧′	...	.....	+ 11.115	+ 3.348	— 27.906
⑦′	....	.....	— 1.000	— 2.573	— 0.003
⑧′	....	.....	+ 1.000	+ 0.301	— 2.510
⑦′ + ⑧′ or ⑨′	....	.....	.....	— 2.272	— 2.513
⑨′	....	....	.....	+ 1.000	+ 1.106
⑧′	....	.....	+ 1.000	(+0.301)(+1.106)	— 2.510
⑤′	....	— 1.000	(—0.218)(—2.843)	(+0.015)(+1.106)	— 8.573
①′	+ 1.000	(+0.068)(+9.210)	.....	(+0.051)(+1.106)	+ 0.576

$$S_E = + 1.106$$
$$S_D = - 2.843$$
$$S_C = + 9.210$$
$$S_B = - 0.106$$

Mr. Maney.

The coefficients of these unknowns, with their signs changed due to transposition, are indicated opposite the equations at the left of the rows and below the unknown S values indicated at the tops of the columns. The details of the solution and the calculations for the S values are shown in Table 5.

Table 6 contains the calculations for the final values of the moments at the ends of the members. The values of S just found are substituted in the equations shown in Table 4. These final moment values are shown in Table 6 to sum up to zero at the various joints.

TABLE 6.—STIFF FRAME CONTAINING AN ARCH MEMBER.

Final Values of End Moments at Joints.

If $S_B = -0.106$ $S_D = -2.843$

$S_C = +9.210$ $S_E = +1.106$

Then:

Joint.	Member Equation.	Moment, 1 000 in-lb.
B	$M_{BA} = -116.0 - 10\,[(4.50)(-0.106)]$	-111.2
	$M_{BC} = +150.0 + 4\,[-2\,(-0.106) - (+9.210)]$	$+114.0$
	$M_{BE} = 0 + 3\,[-2\,(-0.106) - (+1.106)]$	$+2.7$
C	$M_{CB} = -100.0 + 4\,[-2\,(+9.210) - (-1.106)]$	-173.3
	$M_{CD} = +220.0 + 3\,[-2\,(+9.210) - (-2.843)]$	$+173.3$
D	$M_{DC} = -220.0 + 3\,[-2\,(-2.843) - (+9.210)]$	-230.6
	$M_{DF} = +162.0 + 4\,[-2\,(-2.843) - 0]$	$+184.8$
	$M_{DE} = 0 + 10\,[-2\,(-2.843) - (+1.106)]$	$+45.8$
E	$M_{ED} = 0 + 10\,[-2\,(+1.106) - (-2.843)]$	$+6.3$
	$M_{EB} = 0 + 3\,[-2\,(+1.106) - (-0.106)]$	-6.3
F	$M_{AB} = +3\,527 - 10\,[0.77\,(-0.106) + 0]$	$+3527.8$

On Fig. 31 the load line of the arch is shown as a part of two force polygons. The first has a pole which is arbitrary and is determined by any statically determinate condition where the end forces or rays pass through the ends of the axis. The second or correct pole, which determines the final forces acting on the arch, is found by correcting for M_A, M_B, and Fr. The final pressure line may then be drawn, which will check the calculated final moments on the arch member, AB.

Mr. Maney.

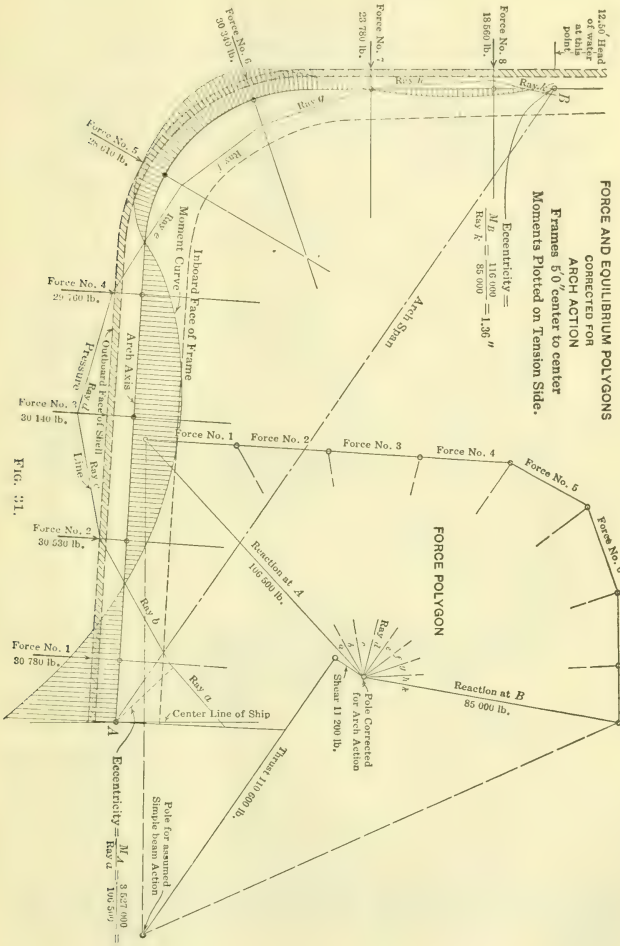


FIG. 31.

Mr. Maney.

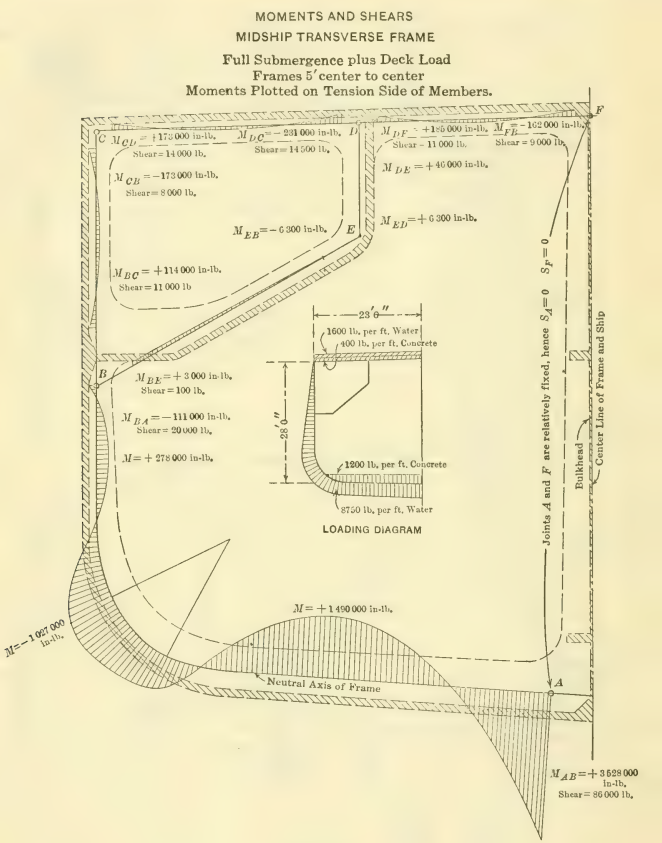

MOMENTS AND SHEARS
MIDSHIP TRANSVERSE FRAME
Full Submergence plus Deck Load
Frames 5′ center to center
Moments Plotted on Tension Side of Members.
C
D
E
F
B
A
M_{CD} = +173 000 in-lb. Shear = 14 000 lb.
M_{DC} = −231 000 in-lb. Shear = 14 500 lb.
M_{DF} = +159 000 in-lb. Shear = 11 000 lb.
M_{FD} = −102 000 in-lb. Shear = 9 000 lb.
M_{DE} = +46 000 in-lb.
M_{CB} = −173 000 in-lb. Shear = 8 000 lb.
M_{EB} = −6 300 in-lb.
M_{ED} = +6 300 in-lb.
M_{BC} = +114 000 in-lb. Shear = 11 000 lb
M_{BE} = +3 000 in-lb. Shear = 100 lb.
M_{BA} = −111 000 in-lb. Shear = 29 000 lb.
M = +278 000 in-lb.
23′ 0″
28′ 0″
1600 lb. per ft. Water
400 lb. per ft. Concrete
1200 lb. per ft. Concrete
8750 lb. per ft. Water
LOADING DIAGRAM
S_A = 0 Joints A and F are relatively fixed, hence S_F = 0
Bulkhead
Center Line of Frame and Ship
M = −1 027 000 in-lb.
M = +1 490 000 in-lb.
Neutral Axis of Frame
M_{AB} = +3 528 000 in-lb. Shear = 86 000 lb.

FIG. 32.

Fig. 32 contains sketches indicating the loading for the whole frame, and the final moments throughout the frame, plotted on the tension side of the axis of the members. The shear values are also indicated.

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PAPERS AND DISCUSSIONS

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THE EAST CANYON CREEK DAM

Discussion.*

By Messrs. Samuel Fortier and A. J. Wiley.

Mr. Fortier.

Samuel Fortier,† M. Am. Soc. C. E. (by letter).‡—As the author has stated, the East Canyon Creek Dam forms part of a co-operative irrigation enterprise known as the Davis and Weber Counties Canal Company, which is owned and controlled by a community of farmers occupying the "Sand Ridge" immediately south of Ogden, Utah. For the past twenty-eight years, the writer has acted first as consulting engineer and, later, as adviser of this Company. The knowledge thus gained of the efforts made by its stockholders during the past quarter of a century to store water for irrigation purposes, is his only excuse for presenting in brief form a few ideas on two phases of this subject, *viz.:*

1.—The advisability—when financial and other conditions warrant —of designing and building dams to impound water for irrigation purposes in progressive stages.

2.—The advantages—where physical conditions permit—of building abutments of gravity section on each side of a canyon at the dam site, and confining the arch to the central portion of the structure.

The first of these phases can best be considered in relation to the enterprise under discussion. In August, 1894, the writer made an examination of the dam site described by the author, and recommended that the company purchase the site and proceed to utilize it to the extent of the funds available and the credit then obtainable on the part of the company; and this was done. As rock was abundant and easily

* Discussion of the paper by A. F. Parker, M. Am. Soc. C. E., continued from May, 1919, *Proceedings*.

† Washington, D. C.

‡ Received by the Secretary, June 3d, 1919.

Mr. Fortier.

obtained, the writer recommended a loose rock dam having a steel core protected by asphalt concrete. The site selected by the writer lay well within the canyon, but, in excavating for a foundation, the officers of the company shifted the site near the upper entrance to the canyon, with a view to lessening the cost of building the foundation. Most of the troubles which subsequently affected this structure were directly traceable to this change of location. The original dam had an effective height of 58 ft. and formed a reservoir with a capacity of 3 850 acre-ft. The topography of the site selected was well adapted to this comparatively low dam, but it was unsuited to the additions to the structure afterward imposed on the original. In 1900, the capacity of the reservoir was increased to 9 000 acre-ft. by raising the dam 25 ft. This increase could not be made by extending the steel core in a vertical direction, for the reason that the upper portion of the steel core as well as the upper portion of the rock filling would have lain outside the canyon. (See Fig. 1.) Accordingly, the steel plates forming the core were inclined down stream at an angle of 45 degrees. Two years later, when the capacity of the reservoir was increased to 14 000 acre-ft. and the effective height of the dam to 100 ft., there seemed to be no other course than to place all the additional rock material on the down stream, as was done before, and continue the extension of the core-wall at the same inclination to the vertical. A cross-section of the original dam and the two additions is shown on Fig. 4.

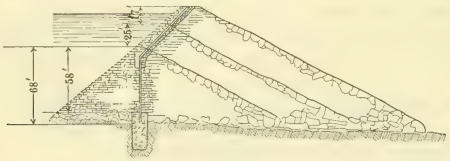

FIG. 4.

In calling attention to the weakest feature of the old structure, it is only fair to add a word bearing on the success of the enterprise as a whole. Before stored water from the reservoir was available, the farmers under the system were not in a prosperous condition. Being one of the late appropriators on the stream, the company was entitled to a portion of the annual flow of Weber River only when there was a surplus. Usually about July 1st of each year, when the discharge of the river was needed by prior appropriators, the company was compelled to close its head-gates and to keep them closed throughout the remainder of the crop-growing season. In consequence, only grain and partial crops of fodder could be raised. Neither orchard trees nor late vegetables could be grown with any assurance of success. With so limited and unreliable a water supply, the farmers could not produce

Mr. Fortier.

the most profitable crops. At that time, the price of improved farming land under the system ranged from $10 to $30 per acre. Water stock of the company having a par value of $50 per share, was not worth more than $10 to $12, and a fair valuation of the property of the company would not have exceeded $250 000.

The use of water stored in the East Canyon Creek Reservoir gradually improved these conditions. As has been stated, the quantity stored was at first relatively small, but, in 1902, it had been increased to nearly 14 000 acre-ft. In 1910, the writer had occasion to examine the affairs of the company and found improved lands selling for $300 and more per acre, the value of the water stock had increased from $12 in 1896 to $175, and the value of the property of the company was conservatively estimated at $1 000 000. During the past eight years, the affairs of this company have improved at a more rapid rate than at any like period of its history, so that at present its financial condition is highly satisfactory.

This much of the history of this enterprise is cited in order to call attention to the feasibility and economic soundness of building dams to store water for irrigation purposes in progressive stages. Considered in the abstract and without reference to local conditions, most engineers would be inclined to condemn such a course as unsafe and unsound, and they might with reason undertake to prove the accuracy of their viewpoint by this same enterprise.

Here is a company that built a dam in 1896 at a cost of more than $50 000, enlarged it in 1900 at a cost of $35 000, enlarged it a second time in 1902 at a further cost of about $25 000, and, in 1915 and 1916, built a new structure from the foundation up at a cost of $193 000, thereby abandoning the greater part of the old structure. Thus, in a period of 20 years, $303 000, exclusive of interest charges, had been expended in storing water. At first sight, it would appear that good engineering practice as well as economy would have called for the construction in the first place of a permanent dam of ample capacity at a cost of less than $200 000.

It is not difficult to show that such a course was impracticable, under conditions then existing, and even if it could have been done, of doubtful economy. The financial condition of the company in 1896 precluded the possibility of raising anything like $200 000 to store water. It was difficult to bond the property to raise $50 000 in order to provide funds to build the original dam. The interest on these bonds was 7½% per annum. Accordingly, the company would have been obliged to abandon the idea of storing water. Some other organization in all probability would have secured the valuable site on East Canyon Creek, and, to-day, the financial status of the Davis and Weber Counties Canal Company might have been in no better shape than it was prior to 1896.

Mr. Fortier.

For the sake of argument, let it be assumed that the stockholders of the company were in a position in 1896 to bond their property to construct a dam capable of impounding 28 000 acre-ft. In the light of subsequent developments, would this course have proved economically sound? The writer does not think so. With the possible exception of the period from 1896 to 1900, inclusive, the water users of the enterprise had sufficient water to meet their requirements and to provide for normal expansion. Unless the surplus could have been sold to other parties, the greater part of the 28 000 acre-ft. stored could not have been utilized. Furthermore, to base an estimate on what actually occurred, it is doubtful if much more than one-half of the storage of the large reservoir would have been utilized for the first 20 years after completion. In the meantime, the unused portion of the stored water would deposit its quota of silt within the reservoir and lessen to that extent its holding capacity.

Furthermore, during this 20-year period, the interest on the cost of a dam capable of impounding 28 000 acre-ft. in excess of the interest on the expenditures actually made in storing water in progressive stages, would have amounted to a large sum. The following figures may convey some idea of this extra interest charge on the basis of 7½%, compounded annually:

Interest on	$193 000	for	20	years.....		$626 900
Interest on	50 000	"	"	"	$162 410	
Interest on	35 000	"	16	"	76 335	
Interest on	25 000	"	14	"	43 815	282 560
		Balance		.....		$344 340

This accounting of the two methods of building dams for the storage of water shows a balance of $344 340 in favor of the plan actually followed. Even when the rate of interest is reduced to 6% per annum, which corresponds more nearly to current rates for such undertakings, the balance in favor of the same plan would still be $230 170.

In order to be understood, it should be stated that the building of dams in separate stages or additions, as herein advocated, might not be economically sound if all the water stored by such structures could be utilized soon after completion. Such a course applies in particular to water stored for irrigation purposes, for the reason that long periods of time usually elapse before even one-half the volume of water stored is utilized. The profile, Fig. 5, based on the returns of the 13th Census, shows the average rate of settlement of irrigation enterprises in the United States.* The profile is based on data secured from 522 enterprises, each containing 5 000 or more irrigable acres. Generally

* "Irrigation in the United States," by R. P. Teele; D. Appleton Company, New York.

speaking, the larger the project, the slower the rate of settlement. Experience has shown that in projects containing 25 000 or more acres, a period of 20 years elapses on an average before 50% of the lands are settled. Mr. Fortier.

In reference to the second phase, in which it is proposed to use a combination of two types of dams, the writer believes such a plan not only feasible but desirable where conditions are suitable.

The nearest approach to this combination type of concrete dam, in so far as the writer is aware, was first made use of by H. Hawgood, M. Am. Soc. C. E., in the design and construction of the Huacal Dam at Nacozari, Sonora, Mexico.* To quote Mr. Hawgood:

"The dam is not of the arch form for its entire length. For 42 ft. at its southeasterly end it is of gravity section, and in direction tangential to the curve."

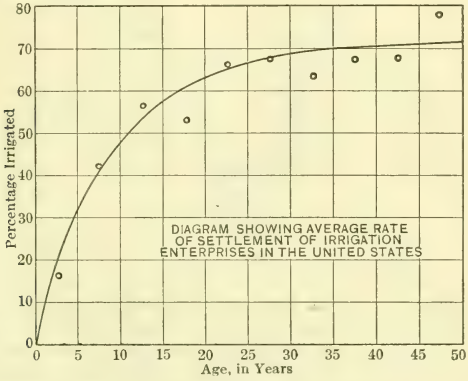

FIG. 5.

He also gives the reason for building a small portion of this structure in this manner, by stating:

"The continuance of the dam on a curve throughout its entire length would have brought the direction of its easterly end too closely parallel to the axis of the canyon to have been economical or safe."

When the writer was consulted in reference to the design of the East Canyon Creek Dam, he did not know that abutments of gravity sections had ever been used in connection with single arch dams. When the plan was proposed by Mr. Parker, the writer gave his approval and urged that both abutments be of this type, but owing to the formation of the rock at the north end, a hollow-deck section was substituted.

* *Transactions*, Am. Soc. C. E., Vol. LXXVIII, p. 564.

Mr. Fortier.

As a result of his observations of the behavior of the East Canyon Creek Dam during the past three years of operation, and his knowledge of dam sites throughout the West, the writer is of the opinion that a new type of combination dam might be developed, in which the abutments of the gravity sections at each end might well be enlarged in the case of spans longer than those of the Huacal Dam or the East Canyon Creek Dam.

A typical cross-section of a canyon at a dam site throughout the mountainous portion of the Far West, based on the observation of the writer, is shown in Fig. 6. It will be noted that the lower portion

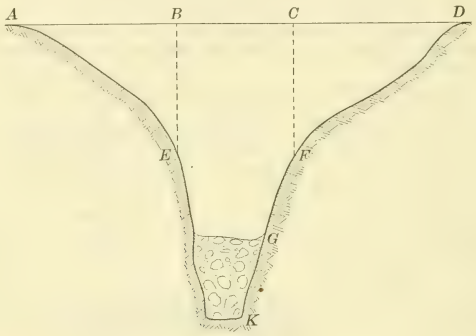

FIG. 6.

extending from bed-rock to nearly one-half the total height, is relatively narrow, with nearly vertical sides, and is filled more or less with sand, gravel, and boulders. From this point the sides slope in the form of the letter V as far as the sides of the canyon rise. Every engineer who has tried to design an arch dam that will fit into these conditions and be adapted equally as well to the narrow lower portion as to the flaring upper portion, has encountered difficulties. Maintaining a constant angle by varying the radii of the arch is only a partial solution, for, as the author has pointed out, cases are rare where it is possible to maintain a constant angle between the limiting radii.

The writer invites the attention of hydraulic engineers to the combination arch and gravity section type as one method of designing concrete dams to conform to cross-sections of sites such as are usually found in deep, rocky canyons. Referring to Fig. 6, the triangular portions, *ABE* and *CDF*, are to be designed as gravity sections, whereas the central portion is to constitute a single arch of substantially equal radii throughout its upper portion, if not throughout its entire height.

Mr. Fortier.

Some of the advantages possessed by the type of dam herein proposed are based on the following facts:

1. The central portion of gravity dams, comprising from one-quarter to one-third the total span, is by far the costliest to build, owing to the height and width of base, which require a relatively large quantity of material.
2. By introducing an arch instead of a gravity section in the costliest portion of the dam, the compressive strength of the concrete rather than its weight is utilized, thus increasing the strength of the structure and lessening its cost.

Beside the saving in cost, this combination type of dam possesses, it is believed, other advantages, of which the expansion and contraction joint is one. It is now quite generally conceded that concrete requires such joints, and concrete dams are no exception to this rule. In the type under consideration, more than ordinary facilities are afforded to make ample provision for both expansion and contraction where the two types come together. Where the arch span is of small or medium length, a joint at each end together with the usual steel reinforcing and the deflection of the arch under pressure should be ample to prevent cracks as well as harmful strains. The experience gained in observing such joints in the East Canyon Creek Dam leads to the conclusion that they are much more effective than those commonly used in all-gravity dams.

Another advantage of this type is its adaptability to the plan of building dams for irrigation purposes in two or more stages, as advocated previously in this discussion. Referring again to Fig. 6, it is readily seen that the foundation and that part of the superstructure up to the height, *F*, might well constitute the first stage. Subsequently, one of the abutments, in whole or in part, followed in time by the other, might be built. Lastly, the construction of the central arch would complete the undertaking.

In conclusion, the writer would call attention to the popularity of arched dams in recent years, notwithstanding the fact that relatively few dam sites are adapted to this type. In the foregoing, he has attempted to outline how dam sites in canyons which have not been properly formed by Nature for such purposes, can be built up in such a way as to afford ideal sites for single arch dams.

Mr. Wiley.

A. J. Wiley,* M. Am. Soc. C. E. (by letter).†—The writer is particularly interested in this complete and satisfactory description of a simple arch dam of unusually great height, because of his experience with a dam of this type where the element of safety was not so important.

* Boise, Idaho.

† Received by the Secretary, June 17th, 1919.

Mr. Wiley.

The Crowley Creek Dam is in Malheur County, Oregon, on a small stream, in a locality remote from settlement, where the only loss from failure would be that resulting to the owners who were willing to take any reasonable risk, in order to reduce the cost of the structure. The site was in a narrow canyon where an arch dam of short radius could be used. The foundations and abutments were of lava rock, and the only feasible location for the spillway was over the top of the dam. The design prepared by the writer was for a concrete arch dam, 60 ft. high above the stream bed, with a radius of 70 ft. The thickness on top and for 30 ft. below was 3 ft. At the base, 60 ft. below the crest, the thickness was 5.2 ft.

The Malheur Land and Livestock Company, for which the designs were prepared, had the dam staked out by an engineer, and employed a local contractor with some experience in concrete work to superintend the work, using the writer's plans and specifications, but without any further engineering aid. The work was carried to a height of 55 ft. above the stream bed in October, November, and December, 1907, and left at this height for a number of years.

The concrete was composed of Portland cement, sand, and gravel of a poorly graded lava character obtained from the creek bed, and the sand was rather fine and very dirty. About the only thing that could be said in favor of either sand or gravel was that they were the best that were available. Cement was used in the proportions of 1 bbl. to 1 yd. of concrete, and enough sand was used with the gravel to make a workable mix. Inspection after completion of the dam shows that little, if any, excavation was made in the rock base for the foundation, and the alignment was so seriously at fault that the radius at the top varied from a minimum of 58 ft. to a maximum of 80 ft.

The length of the dam on top was 170 ft. and, as no contraction joints were provided, a contraction crack opened at the middle point of the dam. This crack was about $\frac{3}{4}$ in. wide at the top of the dam in cool weather, with the reservoir empty, and closed as the reservoir filled. The maximum overflow was about 2 ft. in depth and included large blocks of thick ice.

In September and October, 1915, under the supervision of Mr. A. T. Ingalls, of Boise, Idaho, an additional 15 ft. was placed on top of the dam, giving it a total height of 70 ft. above the stream bed or 10 ft. above that for which it was originally designed. It was intended that the dam should have no reinforcement, but in order to provide to some extent against temperature stresses, the engineer placed a 1-in. square bar at each 3 ft. of the 15-ft. increase in height.

It was found impossible to correct the poor alignment of the original work, so that the top of the completed dam has almost as great a variation in curvature and radius as that work.

Mr. Wiley.

Table 2 shows the thickness and the stresses, in tons per square foot, by the formula for thin arches for various heights of dam for a radius of 70 ft. and for the depth of 2 ft. of overflow to which the dam has been subjected.

TABLE 2.

Depth below crest.	Thickness, in feet.	Stress in Concrete:	
		Tons per square foot.	Pounds per square inch.
0	3.0	1.45	20
10	3.0	8.75	122
20	3.0	16.00	224
30	3.0	23.30	324
40	3.0	30.60	425
50	3.6	31.60	440
60	4.4	30.80	430
70	5.2	30.30	420

The foregoing description is given to illustrate the abuses to which an arch dam sustaining high unit stresses may be subjected without failure.

The writer is also interested in the simple and efficient outlet works used at the East Canyon Creek Dam. This type of tower outlet controlled by three sets of cylindrical balanced valves, as described by the author, was, the writer believes, first used on the Oakley Dam, of the Twin Falls Oakley Land and Water Company, near Oakley, Idaho, and was designed by the writer in co-operation with J. L. Savage, M. Am. Soc. C. E. These outlet works were fully described in the *Engineering Record,* of January 11th, 1913, and have been in operation for about 5 years. They provide the outlet for a reservoir with a capacity of 70 000 acre-ft., and discharge a maximum of 500 sec-ft. The outlet is a tunnel through the rock at one end of the dam, which is of the earth-fill type, 142 ft. high. The tunnel is provided with sluice-gates at its upper end, which are used for drawing off the small quantity of water in the lower 50 ft. The sluice-gates are seldom used, the cylindrical gates being used almost exclusively because of their much greater ease in operation. The cylindrical gates are set at intervals of 30, 60, and 90 ft. below the water surface in a tower 100 ft. high, continued by a shaft, 50 ft. deep, to an intersection with the outlet tunnel, and 20 ft. deeper to provide a water cushion at the bottom of the shaft.

The principal feature of the outlet works of the Oakley Dam are the balanced cylindrical valves which are described very clearly by the author. These valves have given excellent service, and the writer is glad to learn that they have been as successful under the maximum

Mr. Wiley.

head of 150 ft. at the East Canyon Creek Dam as under the head of 90 ft. at the Oakley Dam.

The building of the outlet tower inside of a shaft as a protection against ice is an attractive feature of the author's design and may be necessary in that severe climate, especially if the reservoir contains much water in the winter season. The Oakley Reservoir is usually quite low in winter, and no ill effects have been experienced from the heavy ice, although the gate-tower is in the open reservoir without protection of any kind.

The writer notes that no attempt was made to shape the abutments of the East Canyon Creek Dam to radial lines, but thinks the statement that "the line of the rock made an angle with the line of the resultant of the arch thrust equal to the full angle of repose for masonry" should be read "the normal to the line of rock", etc. It is the writer's practice to specify that the abutments for an arched dam must be stepped back on roughly radial and tangential lines, and that the average line of the points of the steps must not make an angle with the radial line greater than 30 degrees.

The frost conditions under which the concrete was placed, as described by the author, were much more severe than the writer has been accustomed to, and the placing of concrete on a frozen surface, trusting to the removal of the frost by the warmth of the new concrete, is a practice that could only be resorted to under exceptional circumstances.

The cost of the concrete, given by the author as $6.37 per cu. yd., appears to include only the hauling of the cement and the mixing and placing of the concrete, and apparently omits the cost of the cement. If this item is included, the total cost would be $8.60 per cu. yd., a very low cost for reinforced concrete for the small volume and the difficult conditions under which this work was carried out. The writer would like to ask if the costs given are the actual costs or only contract prices, and, if the latter, whether the relation between contract price and actual cost is known?

AMERICAN SOCIETY OF CIVIL ENGINEERS

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PAPERS AND DISCUSSIONS

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PRESSURES IN PENSTOCKS CAUSED BY THE GRADUAL CLOSING OF TURBINE GATES

Discussion*

BY MESSRS. EUGENE E. HALMOS, R. D. JOHNSON, MINTON M. WARREN, T. NOBLE ANDERSON, FORD KURTZ, AND WILLIAM P. CREAGER.

Mr. Halmos.

EUGENE E. HALMOS,† ESQ. (by letter).‡—Ever since the publication of the paper§ entitled "Penstock and Surge-Tank Problems" by Minton M. Warren, Assoc. M. Am. Soc. C. E., the writer has hoped that some one, preferably a member of the Society, would point out the injustice done to one of the greatest hydraulic engineers of the present age by the form of, and the comments appended to, Mr. Warren's presentation of what he termed "Alliévi's formula."

Unfortunately, Mr. Warren has not been corrected. This formula was accepted by American engineers as representing Alliévi's solution of the problem of water-hammer in pipe lines, and, consequently, it has been severely criticized and misinterpreted.

The value of Mr. Gibson's excellent paper is also seriously impaired by the references, both in the text and in the diagrams, to "Alliévi's formula" as taken from Mr. Warren's paper, and the writer would suggest that, after perusal of the following, Mr. Gibson omit all reference to Alliévi, except to state that his solution agrees, in every particular, with that of Alliévi.

The writer proposes to submit a brief summary of Mr. Alliévi's formulas, which, in his judgment, represent a complete solution of

* Discussion of the paper by Norman R. Gibson, M. Am. Soc. C. E., continued from May, 1919, *Proceedings*.

† Designing Engineer, Barclay Parsons and Klapp, New York City.

‡ Received by the Secretary, May 19th, 1919.

§ *Transactions*, Am. Soc. C. E., Vol. LXXIX, p. 238.

Mr. Halmos.

water-hammer problems as regards determination of the pressure at the gate or at any other section of the conduit, at any instant, and under any conditions of closure and physical characteristics of the plant. It is more general than Mr. Gibson's solution, inasmuch as it also includes the determination of the pressure variations after the stopping of the gate movement, and as it gives a method of estimating the interval in which the pressure maximum will occur.

As the present paper and the previous ones deal almost exclusively with the case of water-hammer during the closure of gates, and with the variation of the pressure at or near the gates, the writer will only quote Alliévi with regard to formulas applicable to such cases. The writer, however, intends to translate Alliévi's book into English, which, it is hoped, will be of great help to designers of hydraulic plants and apparatus.

In the following, the formulas representing the relation of time and pressure are given for three phases, namely:

the first phase, for which $t \leqq \frac{2\,L}{a}$;

the second phase, for values of t beginning with $t = \frac{2\,L}{a}$ and ending at T;

and the third phase, $t > T$.

Notation.—

a = velocity of propagation of pressure along pipe;
c_0 = uniform velocity of water in pipe before beginning of gate closure;
C = variable velocity of water in pipe at any instant during gate closure;
u_0 = uniform velocity of water through gate orifice before beginning of closure;
u = variable velocity of water through gate orifice during gate closure;
t = time, in seconds, recorded from beginning of gate movement;
T = duration of gate movement, assumed to be continuous;
L = length of pipe conduit;
y_0 = pressure head on pipe line at gate before closing begins;
y = variable head at gate due to closure.

A.—General Formulas.

(1) *Variation of Pressure Head During and After the Closing Motion of the Gates.*—

First phase, $t \leqq \frac{2\,L}{a}$.

Mr. Halmos.

For this interval, the pressure head, y, at any instant can be computed from the equation

$$y^2 - 2\,y\,\left(H + \frac{a^2\,\psi^2\,(t)}{g}\right) + H^2 = 0 \ldots\ldots\ldots\ldots (1)$$

in which $$H = y_0 + \frac{a\,c_0}{g}$$

and $\psi\,(t)$ is the ratio of the instantaneous area of discharge to the area of the gate opening at the time, $t = 0$, the value of $\psi\,(t)$ being taken at the instant for which the pressure head, y, is calculated.

It will be noted that if the gate is closed in a time, $T \leqq \frac{2\,L}{a}$, $\psi\,(T) = 0$, and the equation reduces to

$$y^2 - 2\,H\,y + H^2 = 0$$

$$y = H = y_0 + \frac{a\,c_0}{g} \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

which shows that in such a case the maximum pressure head is independent of the actual length of the time of closure.

Of the two roots of Equation (1) one is greater, the other is smaller, than H. This latter is the true value of the pressure head at any instant.

Second phase, $\frac{2\,L}{a} \leqq t \leqq T$.

During this period of the gate movement, the following equation applies for the determination of the pressure head at any instant:

$$y^2 - 2\,y\,\left(H - 2\,f + \frac{a^2\,\psi^2\,(t)}{g}\right) + (H - 2\,f)^2 = 0 \ldots\ldots (3)$$

Of the two roots of Equation (3), that giving the smaller value should be used.

It will be noted that this equation differs from Equation (1) only in so far that, instead of H in the latter, $(H - 2\,f)$ appears in Equation (3).

The values of the function, f, should be determined in the following manner:

For the interval, $0 < t < \frac{2\,L}{a}$, $y - y_0 = F\,(t)$, y being calculated from Equation (1).

The velocity, C, in the conduit (at the gate) can be computed from the equation

$$y + \frac{a}{g}\,C = H$$

for this interval.

Mr. Halmos. For the interval, $\frac{2\,L}{a} < t \leq \frac{4\,L}{a}$, $f = F\left(t - \frac{2\,L}{a}\right)$; in other words, the values of $F(t)$ found in the first interval should be substituted for f in Equation (3) to obtain the value of y for every subdivision of the second interval. Then the corresponding values of the velocity, C, may be found by $y + \frac{a}{g}\,C = H - 2\,f$, and the value of $F(t)$ for the second interval by $F(t) = \frac{a}{g}\,(c_0 - C) - f$.

For the third interval, $\frac{4\,L}{a} < t \leq \frac{6\,L}{a}$, the values of $F(t)$ so found for the subdivisions of the second interval should be substituted for f in Equation (3) to get y, and so on, for all subsequent intervals until the gate has stopped moving or has become entirely closed.

Third phase, $t > T$.

If the movement of the gate is stopped at an instant such that $t_1 < \frac{2\,L}{a}$, the pressure head, y, remains constant until $t = \frac{2\,L}{a}$. From this instant on, or from the time of the stoppage, in the case, $t_1 > \frac{2\,L}{a}$, there is developed a hydrodynamic phenomenon in the form of an asymptotical approach of the pressure head, y, to the new constant head, y_0, of uniform flow. There are three different cases.

First.—If $a\,\psi\,(t_1) > \frac{v_0 + v_1}{2}$, in which case y approaches y_0 without oscillations.

Second.—If $a\,\psi\,(t_1) < \frac{v_0 + v_1}{2}$, in which case y approaches y_0 through oscillations of diminishing amplitude.

Third.—If the gate is entirely closed, $\psi\,(t_1) = 0$, the pressure head (disregarding the dampening effect of hydrodynamic friction) oscillates indefinitely, with a constant amplitude, between the value of y, which occurs at the instant of closing, and $2\,y_0 - y_1$, the amplitude being $y_1 - y_0$.

(2) *Estimating the Phase in Which the Maximum Pressure will Occur.*—Assuming a linear closure of the gates:

(a) If $a\,c_0 < 2\,g\,y_0$, then the pressure head at the end of the first phase $\left(t = \frac{2\,L}{a}\right)$ will always be greater than the average maximum pressure (found by Equation (4)) occurring during the second phase.

Mr. Halmos.

(b) If $2 g y_0 < a c_0 < 3 g y_0$, the maximum pressure head occurs either at the end of the first phase, or during the second phase, according to whether the closing time, T, is smaller or greater than

$$\frac{a c_0 - g y_0}{a c_0 - 2 g y_0} \cdot \frac{L}{a}.$$

(c) If $a c_0 > 3 g y_0$, then the maximum pressure will always occur during the second phase and will be greater than that at the end of the first phase.

Equations (1), (2), and (3) are the general formulas derived by Alliévi, by the help of which complete pressure-time curves can be worked out for any assumed conditions of T, L, a, c_0, and y_0. The writer is very much pleased to state, that, by the use of these equations, he was able to check accurately all the curves presented by Mr. Gibson. He wishes to compliment the author in having found, quite independently, and by a simpler mathematical method than Alliévi's functional derivation, the correct formulas for the representation of pressure-time curves and related phenomena.

B.—Special Formulas.

It has been found by experiment, and by working out pressure-time curves for a great number of cases actually met in practice, that, on the assumption of linear gate closure:

(d) The pressure behind the gate remains practically constant for $\frac{2 L}{a} < t \leqq T$ (y is not a function of time or $\frac{d y}{d t} = 0$ between these limits) and, therefore, for this period, the pressure is independent of the elastic qualities of the water and the conduit, in other words, independent of (a);

(e) The pressure is distributed in a linear way along the pipe;

(f) The velocity of the water, C, is the same at any instant at any section of the conduit $\left(\frac{d c}{d x} = 0\right)$.

Taking into consideration the observations noted under (d), (e), and (f), a good average value of y maximum during the second phase can be obtained by solving the equation

$$Z^2 - Z (n^2 + 2) + 1 = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

where $$Z = \frac{y_{max.}}{y_0} \text{ and } n = \frac{c_0 L}{g T y_0}.$$

This equation is identical with Equation (*C*) in Mr. Warren's paper. In order that it should be valid, it is necessary:

Mr. Halmos.

(1) That T be greater than $\frac{2\,L}{a}$;

(2) That the gate movement (the rate of reduction of the area of the outlet) be a linear function of the time;

(3) That, in case of partial closure, that value of T should be used which would be obtained if the gate should be completely closed at the same rate of speed;

(4) That the physical data, as L, a, y_0, and c_0. shall conform to those ordinarily met in practice.

In order that Equation (4) should produce the maximum pressure head obtaining during the whole movement of the gate, it is necessary that $a\ c_0$ shall take the values defined under (b) and (c).

It is evident that Mr. Warren committed a serious error by omitting the publication of Alliévi's general Equations (1), (2), and (3), and by omitting the proper definition of Equation (4) and the limitations of its applicability as defined by Alliévi.

The only ambiguity which may occur in using this formula is the lack of a better definition of Condition (4). This is extremely difficult, on account of the great number of variables entering into the problem. The writer, however, proposes, without being able to give strict analytical proof at the present time, that Equation (4) should be used only, if

$$(\alpha)\quad \frac{L\,c_0}{g\,T\,y_0} < \frac{1}{2}\sqrt{\frac{a\,c_0}{y_0\,g} + \frac{y_0}{y_0 + \frac{a\,c_0}{g}}} - 1;\ \text{and,}$$

$$(\beta)\quad a\,c_0 > 2\,g\,y_0.$$

As L, c_0, a, and y_0 are dependent on rather unalterable physical conditions, if Condition (β) is satisfied, Condition (α) can be fulfilled by determining T according to the proposed formula.

If, besides Conditions (α) and (β), Conditions (b), (c), (1), and (2) are also fulfilled, Equation (4) will give the absolute maximum head at the gate during the movement of the apparatus.

It will be found that,

$$\text{for } c_0 \geqq 10 \text{ ft. per sec.}$$

$$y_0 = \text{between 100 ft. and 500 ft.}$$

$$T \geqq 6 \text{ intervals,}$$

all the foregoing conditions are fulfilled, which means that, in most practical cases, Equation (4) actually furnishes the maximum pressure head at the gate.

If the elasticity of the water and the conduit is neglected for the whole time of the movement of the gate, then, for the conditions for

which Equation (4) is applicable, the pressure-time curve can be platted from the equation: Mr. Halmos.

$$\log. \frac{\left(\sqrt{u_0^2 + u_R^2} + u - u_R\right)\left(\sqrt{u_0^2 + u_R^2} - u_0 + u_R\right)}{\left(\sqrt{u_0^2 + u_R^2} - u + u_R\right)\left(\sqrt{u_0^2 + u_R^2} + u_0 - u_R\right)} = \frac{\sqrt{u_0^2 + u_R^2}}{u_R} \log. \frac{T}{T - t} \quad \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

in which $u_R = K \frac{L}{T}$, where K is the ratio of the area of the gate opening at $t = 0$ to the area of the pipe, and

$$u_0 = \sqrt{2\,g\,y_0}, \quad u = \sqrt{2\,g\,y}.$$

This curve will have a maximum at $t = T$ if Conditions (b) and (c) are fulfilled, and will have a practically horizontal position in the second phase if Condition (α) is observed. It will differ very little from the true curve of pressure variations, and is applicable to practically the whole range of actual water-power problems.

It will be noted that Equations (4) and (5) are identical with Equations (6) and (7) given by Mr. R. D. Johnson in his discussion* of Mr. Warren's paper. Great credit is due to Mr. Johnson for having grasped correctly the essential features of this difficult subject, and for his wonderful mathematical skill in solving by independent methods the intricate problem of water-hammer.

In conclusion, the writer wishes to observe, that it would be desirable to encourage the use of Alliévi's, Gibson's, and Johnson's formulas for water-hammer, and to reject and discourage the use of other formulas, some of which, such as Mr. Warren's, are never true, not even accidentally.

R. D. Johnson,† Esq. (by letter).‡—Mr. Gibson's remarkable paper deserves the closest attention on the part of all who are interested in the water-hammer problem. Mr. Johnson.

He remarks that the theory has not been experimentally confirmed, but it is so obviously complete and correct as scarcely to need such confirmation to establish strong faith in its accuracy.

The writer has been especially interested in a completely correct treatment of this subject, in order to be able to fix the limits of K within which his pressure-time curve, previously presented to the Society, is sufficiently accurate for practical purposes.

It is found, fortunately, that this smooth curve§, $\log. x = n \log. \frac{T}{T - t}$,

* *Transactions*, Am. Soc. C. E., Vol. LXXIX, p. 280.

† New York City.

‡ Received by the Secretary, May 26th, 1919.

§ The derivation of this curve, Equation (7), is given in *Transactions*, Am. Soc. C. E., Vol. LXXIX, p. 280.

Mr. Johnson.

is applicable with much precision to such a wide range of conditions as to justify its use for practically all the water-hammer problems arising in connection with the design and operation, under ordinary heads, of water turbines, when properly regulated.

By differentiating Mr. Gibson's equations, it is possible to express rigidly correct values of the tangents to the true pressure-time curve at (*a*), the beginning of gate closure, (*b*), the end of the first interval, and (*c*), the beginning of the second interval.

Using Mr. Gibson's nomenclature, with omission of subscripts, that is, putting $R_0 = R$, and $S_{T_1} = S$, and $H_0 = H$, these tangents may be expressed as follows:

$$\text{tan. } (a) = \frac{2\,R\,H}{(R + 2\,H)\,T}$$

$$\text{tan. } (b) = \frac{R^2\,(T - T_1)}{H\,T^2}\left\{\frac{S + 2\,R + 2\,H}{\sqrt{S\,(S + 4\,R + 4\,H)}} - 1\right\}$$

$$\text{tan. } (c) = \frac{R^2\,(T - T_1)}{H\,T^2}\left\{\frac{S\,(Z+1) + 2\,R + 2\,H}{\sqrt{S\,(S + 4\,R + 4\,H)}} - (Z + 1)\right\}$$

$$\text{where } Z = \frac{4\,H^2\,T}{R\,(R + 2\,H)\,(T - T_1)}.$$

It is clear that the effects of vibration in the water column, due to elasticity, tend to disappear when the conditions are such that tan. (*b*) and tan. (*c*) approach equality; also, if the change in the rate of pressure rise at the beginning of the second interval, due to the effect of the returning wave, is less than the rate at which the pressure begins to rise when the gate starts to move, it is evident that the conditions are such that the effect of elasticity is rapidly dying out, and that it should be scarcely appreciable during the remainder of the closing period.

If, then, tan. (*b*) — tan. (*c*) < tan. (*a*), the writer's Equation (7), above referred to, or the maximum value of h, given by the so-called Alliévi formula, may be used with much precision.

This may be shown to be the case when.

$$K > \frac{2}{\sqrt{3\,r^2 + 1} - 1} \qquad \ldots\ldots(1)$$

where r is the ratio, $\frac{T - T_1}{T}$; and $K = \frac{R}{H}$.

Equation (1) marks the lower limit for values of K, below which it is not safe to use Equation (7). To find the upper limit of safety, for values of K, it is noted that, as H decreases, the pressure-time diagram passes through a transition stage where an ogee form of curve most

Mr. Johnson.

closely approaches to a straight line, and, that thereafter, as H continues to decrease, Equation (7) begins to produce a curve sharply upturning and curving one way, for the most part, as its extremity reaches toward infinity, thus leading to serious errors in its results.

By trial, assisted by arithmetic integration, it has been noted that, for large values of n, the head may be reduced to about one-half the value which produces the approximate straight-line diagram.

To find this point we may equate the value of $h_{max.}$ in the so-called Alliévi formula to the value of the pressure rise found at the end of a straight-line pressure-time diagram, enclosing the same impulse area, and solve for the value of H.

In this way it is found that

$$K = 3n \ldots\ldots\ldots\

Mr. Johnson.

may be pointed out that much information is available for cases which occur within the limits here set forth, and, inasmuch as his complete work incidentally includes such cases, it may safely be predicted that no error in theory will be discovered by experiment.

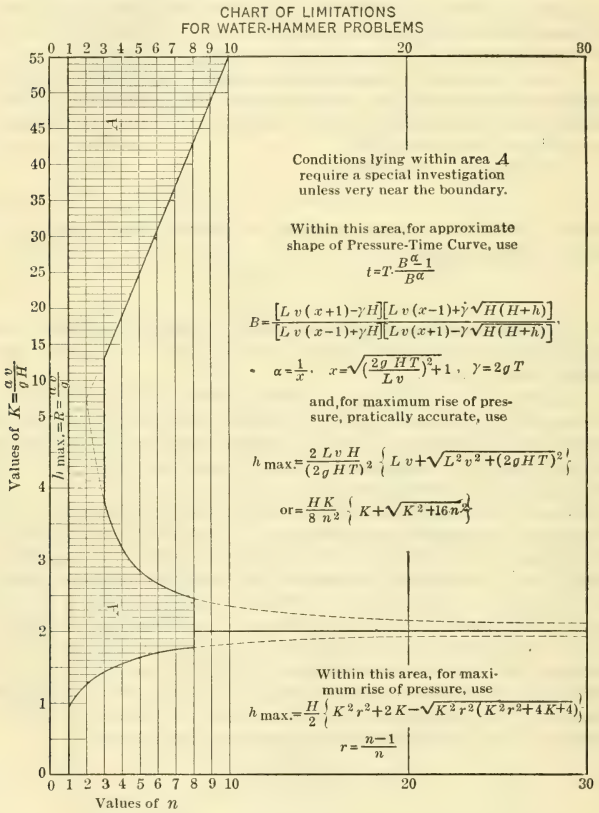
CHART OF LIMITATIONS
FOR WATER-HAMMER PROBLEMS
Conditions lying within area A require a special investigation unless very near the boundary.
Within this area, for approximate shape of Pressure-Time Curve, use
$t=T\cdot\frac{B^{\alpha}-1}{B^{\alpha}}$
$B=\frac{[Lv(x+1)-\gamma H][Lv(x-1)+\gamma\sqrt{H(H+h)}]}{[Lv(x-1)+\gamma H][Lv(x+1)-\gamma\sqrt{H(H+h)}]}$,
$\alpha=\frac{1}{x}$, $x=\sqrt{(\frac{2gHT}{Lv})^2+1}$, $\gamma=2gT$
and, for maximum rise of pressure, pratically accurate, use
$h\,\text{max.}=\frac{2Lv H}{(2gHT)^2}\left\{Lv+\sqrt{L^2v^2+(2gHT)^2}\right\}$
or $=\frac{HK}{8n^2}\left\{K+\sqrt{K^2+16n^2}\right\}$
Within this area, for maximum rise of pressure, use
$h\,\text{max.}=\frac{H}{2}\left\{K^2r^2+2K-\sqrt{K^2r^2(K^2r^2+4K+4)}\right\}$
$r=\frac{n-1}{n}$
Values of $K=\frac{av}{gH}$
$h\,\text{max.}=R=\frac{h}{H}$
Values of n

FIG. 12.

The writer, himself, has confirmed Equation (7) a great many times, under a variety of conditions, in the past twenty years, and, because of such confirmation, he was not led, from practical necessity, to a more thorough investigation of the theory.

Mr. Johnson.

In conclusion, the writer wishes to urge those interested to a further study of the limits here graphically presented, with the idea either of confirming or improving them, because it is not profitable to resort to the very tedious processes incident to the methods presented by Mr. Gibson, except when a comparatively simple formula is inapplicable. The chart, Fig. 12, indicates that this is very rarely the case, and practically never need be, with proper care in the design and operation of any water system.

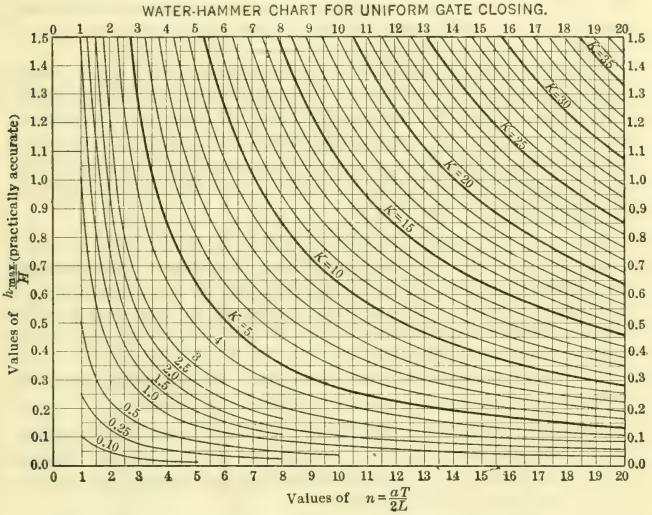

FIG. 13.

It is interesting to note that Mr. Gibson's methods may be used to work out a system of perfectly general cases, thus enlarging, indefinitely, the scope of such diagrams as he has presented, which are based, merely, on a specially selected set of data.

This is made possible by simply substituting in his scale of ordinates, values of the ratio $(h_{max.}) \div H$ in place of $(h_{max.})$, and substituting for the values of H, written on the curves, the values of K.

This trifling change, it will readily be seen, will make such diagrams applicable to an infinite variety of special cases.

In this manner, the chart, Fig. 13, has been roughly prepared, and, for the range of values covered, it is not necessary to resort to formulas.

All combinations of a, V, and H which produce a constant value of K must invariably result in a definite single value of the ratio

Mr. Johnson.

$(h_{max.}) \div H$ for each selected value of n. Therefore, in fact, each point of the chart covers, theoretically, an infinite variety of conditions.

In the use of the chart or simple formulas to replace the accurate but tedious methods, it should be borne in mind that it is not ordinarily practically necessary that the agreement should be perfect, because, as Mr. Gibson has shown, the shape of the curve is so sensitive to the vagaries of the gate motion, in closing, as to make it almost out of the question to reproduce, experimentally, any definitely selected shape of curve; so that, after all, the element of judgment must enter, as usual.

The effects of velocity-head and friction-head have been neglected in the preparation of Figs. 12 and 13. These factors are nearly always of minor importance, as affecting the rise of pressure, but, nevertheless, they may be taken into account by means of arithmetic integration in special cases where great accuracy is thought to be warranted. These effects, at any rate, cannot be included in a usable formula, covering the whole range of the charts.

Mr. Warren.

MINTON M. WARREN,* ASSOC. M. AM. SOC. C. E. (by letter).†—This paper goes into the mathematical theory of ordinary water-hammer more thoroughly than any previous discussion of the question, and is certainly a valuable addition to the literature on this subject. The curves presented by the author show the differences in the various formulas with great clearness.

The writer, however, does not believe that Mr. Gibson's method and formulas are practical for ordinary use for three reasons:

First.—In order to use the formula, a large amount of very tedious figuring must be done, and unless it is very carefully checked by logarithms, a very small arithmetical mistake may make a large error in the result.

Second.—The formulas have not been confirmed by experiments and are based on certain assumptions the accuracy of which are open to question.

Third.—In most cases, simpler formulas will give as accurate results as the data warrant.

It is almost impossible to get away from the idea that the more calculations and exact mathematical methods used in obtaining a result in engineering, the more accurate the result will be, regardless of the assumptions on which the calculation is based. It is the same false accuracy that leads engineers to submit cost estimates figured down to odd cents on projects running into millions.

* Cambridge, Mass.

† Received by the Secretary, July 2d, 1919.

Mr. Warren.

The writer does not believe that the many assumptions needed in deducing any formula for slow-closing gates warrant the elaborate methods used by Mr. Gibson, until these methods and formulas are backed up by careful and extensive experimental data, as were the formulas of Professor Joukovsky.

In arriving at his results, Mr. Gibson assumes that the area of the gate is closed at a uniform rate, whereas the writer, in deducing his simple formula,

$$h = \frac{L\,V}{g\left(T - \frac{L}{a}\right)}$$

assumed that the gate moved in such a way as to cause the pressure to rise at a constant rate. In any given case, neither assumption is strictly true, and experiment alone will show which is nearer the average gate motion.

Referring to Fig. 9,* it is seen that, according to the author's calculations, such a gate motion, giving a constant rise of pressure, is not far from a straight line, and probably as near the truth in ordinary gates as his assumption (uniform reduction of area), which makes the mathematics very much more difficult.

There is great need for a series of careful experiments on slow-closing gates, and it is to be hoped that Mr. Gibson, or some other member of the Society, will undertake this work. Data from such tests properly used would be of more service to the Profession than the most perfect theoretical formulas which have never been tested. Until this is done, engineers will have to base design on the meager practical data available, guiding their judgment by unproved formulas, and the writer has found that the simple formula given above comes nearer the pressures he has observed in practice than other formulas, although, like the others, it is based on certain assumptions which are not strictly true.

In one point, Mr. Gibson's formula gives what appears to the writer unreasonable results. This is illustrated in Fig. 4,† where the curve rises very sharply between heads of from 10 to 100 ft. Alliévi's curve rises even more sharply and can be easily proved wrong, as it reaches values of h which are far above the maximum value possibly reached in instantaneous closing.

Mr. Gibson's curve stops at that value, but the writer does not believe that experiments confirm the large increase in water-hammer for low heads over that for high heads. His assumption that the waves are perfectly reflected from the slowly closing gate is also open to question, and was not proved in Joukovsky's experiments.

* *Proceedings*, Am. Soc. C. E., April, 1919, p. 202.

† *Proceedings*, Am. Soc. C. E., April, 1919, p. 197.

Mr. Warren. It is not intended to imply that Mr. Gibson's formulas may not prove to be as accurate or even more accurate than the others, but, in the absence of any experimental proof, their added complexity does not seem to be warranted, in view of the approximations and assumptions on which they are based.

Mr. Anderson. J. T. Noble Anderson,* M. Am. Soc. C. E. (by letter).†—On several occasions, the writer has investigated this question, or a cognate phenomenon, with pumps—centrifugal and others—through long pipes. In one case, there were two pipes with a common penstock—each of wood, 3 ft. in diameter, and 2 300 feet long. In every case, he has been greatly impressed by the extreme complexity of the subject.

With the help of Professor Joukovsky's theory and some "rule-of-thumb" guesses, gained from a general experience, these pipe lines and the values concerned can now be calculated to as close an economic margin as most other engineering problems. At the same time, the result of experience shows so many baffling discrepancies, that the experimental results, which the author hopes to obtain "in the not too distant future", will be waited for eagerly.

The care he has taken to collect and co-ordinate the formulas, is an earnest that he may be relied on to record fairly and fully not only his results, but all the extraneous facts and happenings which may, however remotely, bear on the many irregularities between actual records and what the formulas anticipate. In particular, it might help if two slightly disturbing factors were recorded in each test, that is: (1) the temperature of the water, and (2) the proportion of free air present in the water.

The second factor will probably be quite immaterial, but, in a case where the substance pumped through a centrifugal was sewage with a specific gravity of 64 lb. per cu. ft., the author found that the gases contained had a very disturbing influence.

In some recent investigations, the writer used a steam indicator with springs specially chosen for the anticipated pressure. Some indication of the author's apparatus will no doubt be given.

Mr. Kurtz. Ford Kurtz,‡ Esq. (by letter).§—Mr. Gibson has made a valuable addition to the too few and scanty English treatises on the mathematical theory of water-hammer. His treatment of the subject, however, is chiefly of value in obtaining, without the use of differential equations and from physical laws the import of which is readily grasped, formulas which give the same practical results as the much simpler and less cumbersome equations of Lorenzo Alliévi, first published in

* Narbethong, Victoria, Australia.

† Received by the Secretary, July 21st, 1919.

‡ Muscle Shoals, Ala.

§ Received by the Secretary, July 28th, 1919.

Mr. Kurtz.

Rome, in 1903. These equations must not be confused with the confessedly approximate and inadequate formula designated by Mr. Gibson* as the "Alliévi formula", and on which Mr. R. D. Johnson has apparently founded a pressure-time equation. The equations referred to are mathematically rigid formulas which take into account not only the effect of net head but also the compressibility of the water and the extensibility of the pipe and which, as far as the writer knows, have never before been published in English. In 1911, the writer prepared, for his own use, a translation of a German translation of Mr. Alliévi's work, and found the latter's treatment so remarkably comprehensive and thorough that he has used it ever since in all water-hammer problems. The German translation† can be found in the Engineering Societies Library.

In presenting the exact formulas of Alliévi, the following nomenclature will be added to that of Mr. Gibson's paper:

$R_0 = \dfrac{a\ V_0}{g}$ = excess, or water-hammer, head due to instantaneous complete closure of gate.

$m = \dfrac{a\ V_0}{g\ H_0}$ = ratio of instantaneous water-hammer head to net head.

$F\ (t)$ and $f\ (t)$, or simply F and f = certain functions of time, t.

$z = \dfrac{H_0 + h_t}{H_0}$ = ratio of total variable head to net head.

$\phi\ (t)$ = gate-opening at time, t, as a ratio of maximum gate-opening.

The exact formulas of Alliévi contain a term which makes it possible to determine the pressure at any point of the pipe line at any moment, but the writer is presenting only the simple form for determining pressure at the outlet, or discharge section just up stream from the gate, as that is the problem investigated by Mr. Gibson. It is also assumed that the pipe line is of uniform thickness and diameter throughout its length. Then, during the period,

$$O < t \leqq \frac{2\ L}{a},$$

$$z = 1 + \frac{F\ (t)}{H_0},$$

where

$$\frac{F\ (t)}{H_0} = m + \frac{m^2}{2}[\phi\ (t)]^2 - m\ \phi\ (t)\sqrt{1 + m + \frac{m^2}{4}[\phi\ (t)]^2}$$

* *Proceedings*, Am. Soc. C. E., April, 1919, p. 193 *et seq.*

† "Allgemeine Theorie über die veränderliche Bewegung des Wassers in Leitungen", von Lorenzo Alliévi, 1909.

Mr. Kurtz.

and, during the period,

$$\frac{2\,L}{a} < t \leqq T,$$

$$z = 1 + \frac{F\,(t)}{H_0} - \frac{F\left(t - \frac{2\,L}{a}\right)}{H_0} = 1 + \frac{F\,(t)}{H_0} - \frac{f\,(t)}{H_0},$$

where

$$\frac{F\,(t)}{H_0} = m - \frac{f\,(t)}{H_0} + \frac{m^2}{2}\,[\phi\,(t)]^2$$

$$- m\,\phi\,(t)\,\sqrt{1 + m - \frac{2\,f\,(t)}{H_0} + \frac{m^2}{4}\,[\phi\,(t)]^2}$$

For the linear law of gate movement, $\phi\,(t) = 1 - \frac{t}{T}$, as already stated by Mr. Gibson.

These formulas applied to Mr. Gibson's first example give the following equations:

For $$O < t \leqq 0.35 \text{ sec.},$$

$$\frac{F\,(t)}{H_0} = 10.35008 + 53.56185\,\phi^2 - 10.35008\sqrt{11.35008\,\phi^2 + 26.78092\,\phi^4}$$

and, for $$0.35 < t \leqq 6.0 \text{ sec.},$$

$$\frac{F\,(t)}{H_0} = 10.35008 - \frac{f\,(t)}{H_0} + 53.56185\,\phi^2$$

$$- 10.35008\sqrt{\left(11.35008 - \frac{2\,f\,(t)}{H_0}\right)\phi^2 + 26.78092\,\phi^4}$$

As already noted by Mr. Gibson, the values of $\frac{F\,(t)}{H_0}$ and $\frac{f\,(t)}{H_0}$ are so small compared with some of the individual terms of the equations, that it is necessary to use logarithms in solving the equations.

Using the exact Alliévi equations as given previously, Table 6 has been prepared, showing the rise of pressure and also the differences between the values of the rise obtained by Alliévi equations and those obtained by Mr. Gibson's equations. The maximum divergence of less than one-half of 1% shows the remarkable agreement of the two methods. It is apparent, however, that the simplicity of the solution by the Alliévi formulas, without giving heed to magnitude and direction of waves in the computations, makes it far superior to that of Mr. Gibson as a working method.

The exact formulas of Alliévi also furnish equations similar to those given previously for the case of the opening of a valve at the

Mr. Kurtz.

lower end of a pipe line, either from fully closed position, or from some initial partial opening. As already stated, in their complete form they also give the pressure at any time for any point along the pipe line, thus covering the matter mentioned by Mr. Gibson as to be discussed by O. V. Kruse, Assoc. M. Am. Soc. C. E.* Of course, there are also exact equations for the velocity at any time for any point along the pipe line.

The partial differential equations for the general motion of water in pipes are based on the fundamental differential formulas for the motion of water in general. Unfortunately, these partial differential equations, four in number, cannot be integrated (not even by approximate arithmetic integration so far as the writer knows) without making the following simplifying approximations:

1. Velocity in direction of axis of pipe considered uniform over any chosen section of the stream.

2. Skin friction and viscosity neglected.

3. Velocities at right angles to the axis of the pipe, due to expansion or contraction of the pipe by changes in pressure, neglected.

4. Pressure considered uniform over any chosen section of the stream.

5. Assumed that the pipe consists of individual circular elements independent of each other, which are freely extensible.

6. Assumed that the ratio of velocity of water in the pipe to the velocity of propagation of pressure changes is small enough, compared with unity, so that its addition thereto or subtraction therefrom can be neglected in every case at every instant.

By making these approximations, we obtain the so-called exact formulas of Alliévi.

Mr. Gibson's method of taking account of skin friction (which is only approximate, as has been pointed out by William P. Creager, M. Am. Soc. C. E.) could easily be applied to the exact Alliévi formulas by changing the factor m so as to have it correspond at all times to $(H_0 + h_f)$ instead of to H_0. The exact Alliévi formulas can be applied so as to take account of varying diameters and thicknesses of pipe in the same line, but they soon lead to so much complication that they become impracticable. In such cases, the writer uses the formulas as already given for a pipe of uniform diameter and thickness, but gives to m the value, $\dfrac{Q_0 \Sigma \dfrac{L}{A}}{g H_0 \Sigma \dfrac{L}{a}}$, where Q_0 equals the flow of water in a pipe at full gate-opening, L equals the length of any section of pipe, A, its

* *Proceedings*, Am. Soc. C. E., May, 1919, p. 339.

Mr. Kurtz.

TABLE 6.

Interval in terms of $\frac{2L}{a}$	$\phi(t)$	$\frac{F(t)}{H_0}$	$\frac{f(t)}{H_0} = \frac{F\left(t-\frac{2L}{a}\right)}{H_0}$	$z-1$	h_t, Allievi	h_t Gibson	Percentage of divergence.
0	1.00000	0.00000	.....	0.00000	0.00	0.00	.....
¼	0.95833	0.07338	.....	0.07338	12.10	12.12	0.16
½	0.91667	0.15476	.....	0.15476	25.53	25.53	0.00
¾	0.875	0.24503	.....	0.24503	40.43	40.41	0.05
1	0.83333	0.34550	0.00000	0.34550	57.01	56.96	0.09
¼	0.79167	0.49780	0.07338	0.42442	70.03	69.94	0.13
½	0.75	0.66286	0.15476	0.50810	83.84	83.72	0.14
¾	0.70833	0.84160	0.24503	0.59657	98.43	98.31	0.12
2	0.66667	1.03529	0.34550	0.68979	113.82	113.63	0.17
¼	0.625	1.26152	0.49780	0.76372	126.01	125.78	0.18
½	0.58333	1.50125	0.66286	0.83839	138.33	138.05	0.20
¾	0.54167	1.75454	0.84160	0.91294	150.64	150.32	0.21
3	0.5	2.02152	1.03529	0.98623	162.73	162.42	0.19
¼	0.45833	2.30592	1.26152	1.04440	172.33	171.97	0.21
½	0.41667	2.60055	1.50125	1.09930	181.38	181.10	0.15
¾	0.375	2.90456	1.75454	1.15002	189 75	189.43	0.17
4	0.33333	3.21686	2.02152	1.19534	197.23	196.77	0.23
¼	0.29167	3.53609	2.30592	1.23017	202.98	202.49	0.24
½	0.25	3.86010	2.60055	1.25955	207.83	207.14	0.33
¾	0.20833	4.18755	2.90456	1.28299	211.69	211.00	0.33
5	0.16667	4.51715	3.21686	1.30029	214.55	213.79	0.35
¼	0.125	4.84719	3.53609	1.31110	216.33	215.75	0.26
½	0.08333	5.17707	3.86010	1.31697	217.30	216.71	0.26
¾	0.04167	5.50630	4.18755	1.31875	217.59	216.95	0.28
6	0.00000	5.83293	4.51715	1.31578	217.10	216.57	0.23
Average percentage	.....	.....	.....	.....	.....	.....	0.20

cross-sectional area, and a, its individual value of the velocity of propagation of pressure changes. Also, the factor, $\frac{2L}{a}$, must everywhere be changed to read $2 \Sigma \frac{L}{a}$. This is confessedly an approximation made without mathematical proof, but it is probably exact enough for practical purposes in the majority of problems.

Mr. Creager.

WILLIAM P. CREAGER,* M. AM. SOC. C. E. (by letter).†—The theory of water-hammer in penstocks is one of the most intricate problems confronting engineers. Mr. Gibson has made a considerable addition to the knowledge of the subject; but exact solutions for all conditions have not yet been reached.

The author has developed rational equations for penstocks of constant diameter and negligible friction head. In cases where friction head is relatively large, and particularly where the penstock has a varying diameter, we are still very far from a practical solution.

* New York City.

† Received by the Secretary, August 6th, 1919.

Mr. Creager.

At any instant during gate closure, the discharge through the gate is a function of the static head plus water-hammer head less friction head, all measured at the gate.

On page 191,* the author makes the assumption that the friction head at the gate is proportional to the square of the velocity adjacent to the gate. This assumption appears to the writer to be only approximate, since it is well known that, at any instant during surges, the velocity is materially different at different points on the penstock.

It is the writer's opinion that, during the period, $\frac{2L}{a}$, subsequent to a single small instantaneous closure, the friction head at the gate is not constant, although the velocity adjacent to the gate during that period is constant. This constantly varying friction head makes it very difficult to include this feature in the equations for water-hammer and, in all probability, the author's methods are as close as can be obtained. It would be of interest to know how much difference the incorporation of friction head makes in ordinary problems.

For a penstock with varying diameter, auxiliary waves are set up each time a water-hammer wave passes a point of change in diameter. For this condition, the author's equations would not apply. His methods would apply, but they would be exceedingly difficult, if not impossible, of practical application.

It is evident that the maximum rise of pressure is materially influenced by the characteristics of the gate-closure curve. It is well known that modern turbine governors do not provide a uniform rate of gate closure throughout the stroke. It is also possible that governors of different types have different closure characteristics. Consequently, complete data for the determination of maximum water-hammer for specific cases must include the gate-closure characteristics of the governor which is to be a part of the machinery.

* *Proceedings*, Am. Soc. C. E., April, 1919.

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PAPERS AND DISCUSSIONS

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SEWAGE AND WASTES DISPOSAL FOR THE UNITED STATES ARMY

Discussion*

By Messrs. Leonard Metcalf, Nicholas S. Hill, Jr., Almon L. Fales, Kenneth Allen, and G. Bertram Kershaw.

Mr. Metcalf.

Leonard Metcalf,† M. Am. Soc. C. E.—This paper has summed up in a very good, descriptive way the admirable work done by the Construction Division. It is to be hoped that before Maj. Doten completes his work on this subject, he will submit with his paper some of the analytical results which have been made, bearing on the operation of the plants.

In judging of the work done in this branch of the service, as in the work of actually building the cantonments, one must remember the very short time which was available, in the first instance, for building the sewerage systems, as well as the camps.

The periods for which the camps were to be operated, was a very important factor in determining the most desirable kind of disposal.

Maj. Doten perhaps has not given as clear an idea of his worries in consequence of the grease problem, because the conditions, as he has pointed them out, have been found to be quite different from those realized in many municipal plants, and have been a source of very great difficulty.

The question of how to handle the grease problem in the best way, involved the question as to whether or not it would be possible, with so many different buildings, so many different centers in the camp, to

* This discussion (of the paper by Leonard S. Doten, M. Am. Soc. C. E., published in May, 1919, *Proceedings*, and presented at the meeting of December 18th, 1918), is printed in *Proceedings*, in order that the views expressed may be brought before all members for further discussion.

† Boston, Mass.

Mr. Metcalf.

separate the grease, as was desirable, before it mingled with the fæcal matter, because the grease would obviously be much more valuable, be more salable, if the separation could be made. The way in which this problem has been worked out seems to the speaker to be good.

Final judgment on it cannot yet be passed, perhaps, but certainly the underlying principles—to have a large area for cooling the hot liquids, the tubs of dish-water that are turned into the sink, which on account of their volume and temperature tend to carry the grease forward; the small outlet, which will give scouring velocity; and sufficient slopes to enable the traps to clear themselves of solid matter—are all sound. Although some changes may be necessary, perhaps, a definite step in advance seems to have been made in the matter of the economical handling of the grease problem in camps and cantonments.

There is also included in this grease problem the question of good administration. It has been felt very markedly in these cantonments, as well as in municipal plants, and is a factor which has to be kept in mind by the designing engineer when he comes to pass on the details of his plant, because it is possible in military camps to give orders and to have them enforced in a way which is not always possible in municipal plants.

The acid or alkaline character of the sewage solids in the tanks varies with the character of the water supply, and affects the sludge digestion.

The best design for the tank which Maj. Doten has shown, and its efficiency as a digestion tank, is still open to debate and proof. It is a question on which various men who have observed these tanks, and some who have made experiments on them, perhaps differ; and for that reason it is desirable for Maj. Doten to submit the facts, as he has been able to develop them, with the greater facilities which he has had recently for following by chemical analysis in a general way the operation of these tanks.

It has seemed to the speaker, as he has visited and viewed perhaps twelve or fifteen of the camps, in the West, in the South, and around New York City, though he has not had the opportunity recently to keep closely in touch with them, that the tank was more essentially a clarification than a digestion tank, and that its most effective operation was found in its use as a sedimentation tank rather than as a digestion tank. This was anticipated in principle by some, and, it is believed, has been proved in operation.

On that question Maj. Doten may differ radically with the speaker, and that is one reason for hoping that he will give the facts, in order that the truth may be established.

In the early operation of the tanks, it is to be borne in mind that the available capacity was substantially greater than later, when the numbers of men at the camps had increased. The tanks were designed

Mr. Metcalf.

on the basis of 10 gal. per capita. On the basis of that capacity, experience seems to have demonstrated that they could not act as true digestion tanks. In other words, when the attempt was made to operate them as digestion as well as sedimentation tanks, they were soon gorged, and the accumulated solids had to be removed. Sedimentation was their best function, under those circumstances, and, if so, it is necessary to limit the accumulation of solids in the first compartment of the tank by removal of the excess of sludge and scum in order that the digestion process can go on in the other compartments. If solids are removed, as has been necessary, the question immediately arises, what is the relative percentage of the solids disposed of by digestion, on the one hand, and by sedimentation and removal in an undigested state, on the other.

The effect of the different methods of operation on the freshness or staleness of the tank effluent is also of much importance. As the process of removal is not a pleasant one, it is to be avoided as far as practicable.

Good judgment was shown in the adoption of the 10 gal. per capita basis of design, chosen as an economical procedure, for the reason that the life of the camps, and hence of the disposal works, was limited to a period of 5 years, and that it was recognized that it might not be greater than 2 years. That has proved to be the case in the majority of the camps. The lower first cost of sedimentation tanks was balanced against the lower operating expenses of digestion tanks.

The speaker questions whether the form of the pyramidal bottom was worth its cost, as observed at the various camps. There is no doubt that the tank with a pyramidal bottom was materially more expensive than a rectangular tank of the same capacity. It may be questioned whether in operation it was any more economical, because the slopes are not steep enough to force the solids down. On the other hand, they are so steep as to be impossible to stand on for scraping, though they can be flushed by hose.

The speaker is very much surprised at Maj. Doten's statement in regard to the efficiency of tanks of various depths, because this appears to be out of line with the results of experiment, and of experience in municipal plants in the United States which have been operated up to this time, so far as the speaker knows them. It is to be presumed that Maj. Doten speaks with knowledge derived from his experience, and, therefore, his evidence will be awaited with interest.

In the matter of placing the sprinkler nozzles on the trickling filter beds on a slope, that is, not in the same plane, the speaker's observation has indicated it to be distinctly disadvantageous rather than advantageous, as it has resulted in overtaxing locally certain portions of the bed, and has failed to give as good distribution as under the more usual course of procedure.

Mr. Metcalf. In so far as municipal practice is concerned, some other types of under-drains will probably prove more advantageous than the form which has been used in these camps; nevertheless, good judgment was shown by Maj. Doten in using the simplest form, in the interest of greater economy for temporary construction. Maj. Doten's record of service is much to his credit.

Mr. Hill. NICHOLAS S. HILL, JR.,* M. AM. SOC. C. E.—Mr. Metcalf has covered some of the points which the speaker had in mind to make. He wishes, however, to emphasize the statement that these tanks are primarily clarification tanks, and not digestion tanks. From his connection with their operation, the speaker feels that a saving in first cost could have effected, and with as satisfactory results, if their design had been simplified. He is satisfied that the division into compartments was a mistake. At Camp Merritt it was found that the major part of the sedimentation occurred in the first compartment, and that the second, third, and fourth compartments contained only a small quantity of sludge. In fact, at Camp Merritt, a by-pass was provided from the first tank, and arranged so that sludge could be transferred therefrom to the second, third, and fourth compartments. If this had not been done, the first compartment would have had to be cleaned frequently, and it would have been necessary to clean the remaining compartments at intervals, increasing in length, up to a maximum for the last compartment.

The speaker has serious doubts about the design of the grease traps adopted, and whether the high velocity idea is a practical one. He would not design a grease trap along the lines of the one used for the cantonments, and, from observation of the operation of these traps, he knows that there was lost from them a large quantity of grease which could have been saved with slight modifications of design.

In the camp with which the speaker had to do, difficulty was found in getting those who attended to the grease traps to remove the grease from the surface around them. The result was that with grease lying on the surface in the summer, an attractive center for flies was created, which was objectionable, particularly as the traps were near the kitchens. It is realized that it was necessary to remove the grease at the source of production, before it mingled with human wastes, if it was to be obtained in a condition ready for use, but the system of placing individual grease traps on kitchen connections in municipalities would be impracticable, for various reasons, and, if grease is to be withdrawn from the sewage, it will have to be done at the point where the sewage is treated. The speaker mentions this for fear that some one, reading of the successful operation of the grease traps in the cantonments, will seize on the idea that a large return can be secured in municipalities by adopting the same process. If individual grease

* New York City.

traps can be adapted to municipal work, their form will certainly have to be modified materially from that used at the cantonments. Mr. Hill.

The general design for the sewerage systems for the cantonments showed much foresight on the part of those who laid them out, and the assumptions which were made were borne out in general by actual experience in the several camps. The design generally is to be commended.

In connection with the work of construction, it might be well to refer to the use of trenching machines. The conditions at Camp Merritt were such that the use of these machines was practically impossible. The contractors procured ten or twelve of them, with the idea of doing the work expeditiously, but when the trenches were opened, rock was found in some cases, and in other cases the sandy soil contained water, and where that was the case, it was found that hand labor was more economical than the trenching machine, because it was practically impossible to sheathe the trench directly behind the machine. The trench caved in, and the hand work required in removing the fallen material was almost equivalent to that which had to be done originally. A number of methods of working behind these trenching machines in wet ditches was tried without success. They may be modified so that they can be used where the trenches are wet, but, as designed to-day, they are not useful under such conditions. These machines were handicapped to such an extent in various places, on account of obstructions, that hand work had to be resorted to for a large proportion of the work, and at Camp Merritt hand labor was found to be more expeditious and cheaper. Of course, where the trenches were shallow, as in the case of water mains, a small trenching machine was used to great advantage. The difficulties referred to relate more particularly to the use of these machines for sewer work.

Almon L. Fales,* M. Am. Soc. C. E.—This paper is especially interesting to the speaker, because of his work for the Construction Division of the Army, in connection with water supply and sewage treatment at the army camps. He has inspected the sewage tanks, designed by Maj. Doten, in operation at numerous camps, and has made thorough investigation of their efficiency at several of the camps. Mr. Fales.

The efficiency of sewage tanks may be judged by three important standards:

1.—Removal of suspended solids in the sewage, which will settle to the bottom as sludge or rise to the top as scum;

2.—Digestion of the solids removed, with the production of inoffensive matter;

3.—Reduction in biochemical oxygen demand of the sewage, measured by the relative volumes of diluting water necessary to render the sewage and tank effluent non-putrefactive.

* Boston, Mass.

Mr. Fales.

Judged by the first and third of these standards, these tanks were found to be very efficient, when the accumulation of sludge and scum was removed with sufficient frequency to avoid excessive fermentation or septic action and to prevent disgorgement of solids at times of high flow. In other words, they were efficient when operated as plain sedimentation tanks. The nature of the fresh uncomminuted camp sewage is favorable to the removal of a large proportion of the suspended solids by sedimentation and flotation.

Judged by the second standard—digestion of solids—these tanks were not efficient, with a capacity of 10 gal. per capita served, which was the basis of design; and tests at one camp indicated that complete digestion of the solids could not be secured even with a capacity as high as 35 gal. per capita. At several camps some well-digested sludge was produced in the third and fourth compartments, due, in part at least, to the mechanical separation of the less easily digested solids in the first and second compartments, but, as far as the speaker is aware, in no case was the rate of production of well-digested sludge equal to the rate of accumulation of fresh solids in the tank.

To what extent the inefficiency of the tanks in the digestion of solids was due to the large proportion of fats in the camp sewage has not been ascertained. There is no doubt that some improvement will result from placing efficient grease traps on the kitchen drains. With such traps it seems certain that satisfactory digestion of the solids can be secured, if unlimited tank area and capacity are available. The area and capacity required in the tanks to accomplish this have not been determined, but they exceed by far the basis of design.

If the tanks are made adequate for the digestion of the solids, and are operated according to the principle of the designer, the tank effluent will be charged with the gaseous and liquid products of digestion and with more or less finely-divided suspended and colloidal matter, resulting from the process of digestion. The effect of this action is to render the tanks inefficient, judged by the third standard, namely, the reduction in the biochemical oxygen demand of the sewage. At some camps, where digestion was taking place, the tank effluent was found to have a higher oxygen demand than the crude sewage itself. Such a tank effluent is likely to be malodorous and to require an abnormally large proportion of chlorine for disinfection, and a relatively large volume of diluting water to render it non-putrescible. Further, it is the consensus of opinion that such a tank effluent cannot be treated by processes of bacterial oxidation—such as filtration through trickling filters—as advantageously as one which is not affected by the products of decomposition of the sewage solids.

In the speaker's opinion, to secure efficient tank treatment it is necessary to separate the functions of sedimentation and sludge digestion. This may be accomplished by the so-called two-story tank, in

which the opening from the sedimentation compartment into the sludge compartment is trapped; by separate sludge digestion tanks; or by operating tank units in rotation, first for sedimentation and then for sludge digestion. Mr. Fales.

In accordance with the recommendation of the consulting engineers (Messrs. Fuller and McClintock, and Metcalf and Eddy), the number of tank units, at most of the large camps, has been, or is being, increased to at least five of 7.5 gal. per capita each, in order to permit of operation by the rotation method; and provision is made for pumping the sludge and scum from any compartment of any tank to any other compartment, in order to facilitate the digestion of the solids.

The speaker is glad to corroborate what Maj. Doten has said in regard to the character of the effluent from the sedimentation tanks at the Great Lakes Naval Station.

At the time the speaker was there, this effluent was characteristic of that from septic tanks—black and foul and heavily charged with fine suspended matter, probably to a large extent sulphide of iron. In answer to a question raised by the speaker, he was informed that it was out of the question to allow this effluent to flow down the aerating effluent flume, on account of the foul odors created.

This condition of the effluent was evidently due to the presence of decomposing sludge in the sedimentation tanks, and illustrates the effect of attempting to secure sedimentation and sludge digestion in the same tank, at the same time.

Whether the sludge was not being drawn from the sedimentation tanks into the separate sludge digestion tanks with sufficient frequency, or whether the bottom slopes of the sedimentation tanks were not steep enough to be self-cleansing, and thereby prevent accumulations of solids in the tanks, was not ascertained.

Kenneth Allen,* M. Am. Soc. C. E.—It might be of interest to mention a tank devised by J. W. Alvord, M. Am. Soc. C. E., and used as a standard by the United States Housing Corporation. Mr. Allen.

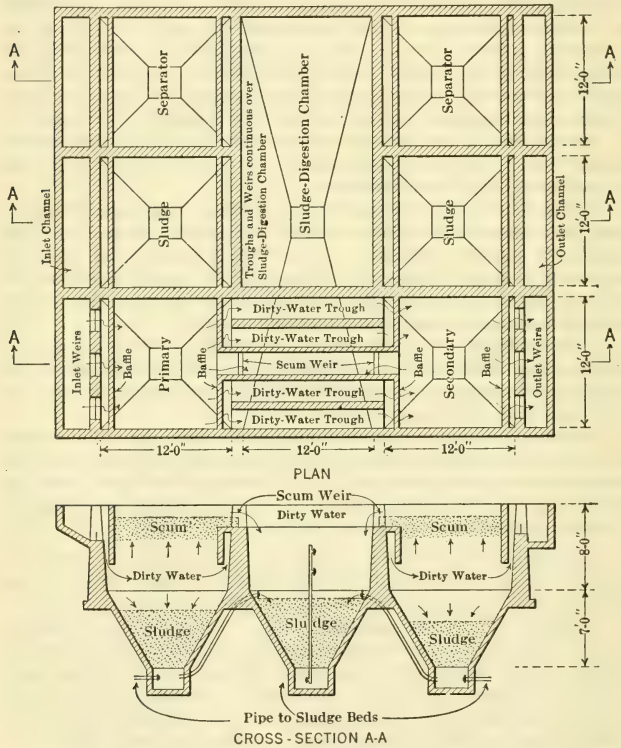
The unit (Fig. 6) is supposed to serve for a 1,000-house development. It consists of a primary settling tank with three hopper bottoms 12 ft. square, sloping 60° from the horizontal, and extending some 16 or 17 ft. below the top of the tank; a secondary settling tank, similar and parallel to the one described; and, between these two, a sludge digestion tank of equal length, width, and depth, but with a single hopper.

The baffled sewage flows from the primary to the secondary tank over the sludge tank by several troughs, and the scum can be pushed along special troughs connecting each settling tank with the sludge tank.

* New York City.

Mr. Allen.

The sludge which collects in the six hoppers of the primary and secondary tanks is drawn into the hopper of the sludge tank merely by lowering the surface of the liquid in the latter a foot or so, is retained there until digested, and is then drawn off by a sludge pipe in the bottom.



TYPICAL POSITIVE SEWAGE SEPARATOR AND DIGESTOR
FOR FRESH SEWAGE
1000-HOUSE DEVELOPMENT
FOLLOWING PRINCIPLES PROPOSED BY JOHN W. ALVORD - CONSULTING ENGINEER

FIG. 6.

With a few feet of fall to the sludge bed, there is seen to be no necessity for pumping the sludge, the movement of which is controlled by valves.

Mr. Allen.

The tank is designed especially for fresh domestic sewage, such as is produced in small towns or cantonments, with an effluent, after a detention of from 30 to 50 min., still relatively fresh and containing dissolved oxygen. To obviate the difficult and objectionable removal and disposal of scum by hand, this is readily disposed of with the sludge. A further advantage lies in avoiding the excessively deep excavation usually necessary with the Imhoff tank.

A tank of this description has been in continuous operation at the Great Lakes Naval Training Station since October, 1917. It consists of three units, each designed to handle 1 000 000 gal. per day, with a detention period of 45 min. in each tank. It is understood that there has been no appreciable accumulation of sludge at this plant, and that it has been very successful in operation. The small quantity of sludge has been attributed to an increased fermentation due to an occasional seeding with a wisp of hay, but this is not believed to be proved as yet.

The speaker does not know what difference there is between the character of the sewage at these works and that at the cantonments. The plants of the Housing Corporation have not been operating long enough to reach a determination, but that at the Great Lakes Station has been in use for more than a year, and, thus far, seems to have given good results.

With reference to the Great Lakes plant, the following additional information has been received from L. R. Howson, Assoc. M. Am. Soc. C. E., who has been intimately connected with its design and operation:

"The writer visited the Great Lakes Station on Thursday of this week—the day before your letter was received.

"The tanks have been practically free from odor, even in the immediate vicinity of the plant, and entirely free from odor at a distance as great as 50 or 100 ft.

"The sewage is very fresh, the age of the sewage when it reaches the plant being from 5 min. to a little over an hour from point of origin to the time it reaches the plant. The average age is less than 45 min. This and its purely domestic character account for the formation of great quantities of scum and very little sludge. The scum forms to a depth of from 2 to 3 ft. per week over the primary tanks.

"The tanks have operated very successfully, and an average of approximately 80% of the suspended matter has been removed by these tanks alone.

"When the tanks were first placed in operation a strong hydrogen sulphide odor was observed. The chemist at the Naval Training Station did considerable experimental work to overcome this odor, and worked out some interesting data with regard to liquefying this sludge and scum.

"The sludge digestion chamber was also seeded with liquefying bacteria, with the result that the plant has now been in operation for a year and a half, operating the greater part of the time at approximately 50% greater rate than that for which it was designed, and, although the sludge has been discharged into the central digestion chamber at weekly intervals, it has not been necessary to draw off

Mr. Allen.

any sludge to the sludge beds to date, although the comparatively clear liquid resulting from the liquefying of the sludge has necessarily been disposed of.

"There have been some difficulties observed in the operation of the plant as a whole, which are not, however, attributable to the tanks. We had some 40 ft. of head to spare between the tanks, which are on the bluff, and the filtration plant at the foot of the bluff. This was utilized by aerating steps, which we considered and showed on our plans as being desirable for use at certain seasons of the year and when the wind was off-shore. The base hospital with its additions are within 300 ft. of the sewage disposal plant, and it must therefore operate entirely free from odor at such time as the wind is blowing on shore and from the plant toward the hospital buildings. The only complaints from odors which we have observed have been due to the use of the aerating steps, and these have been very slight. The use of the steps is now discontinued, and they will not be used except during favorable wind conditions."

Plants of this type have been built at Madison, Wis., Aberdeen, Md., Bethlehem, Pa. and Swedeland, Pa.

Mr. Kershaw.

G. BERTRAM KERSHAW,* M. AM. SOC. C. E. (by letter).†—This paper brings out the marked difference between municipal and camp sewages, the latter not only being considerably stronger, but, in addition, containing considerable grease.

It may be of interest, for purposes of comparison, to give some figures of analysis for an ordinary domestic sewage and for a barracks sewage, the latter in Great Britain differing but litttle from camp sewage. The following figures relate to the average of three sets of hourly samples, taken at the Aldershot Camp Sewage Farm:

	Parts per 100 000.	Parts per 1 000 000.
Ammoniacal nitrogen	7.87	78.7
Total organic nitrogen	5.06	50.6
Albumenoid nitrogen	1.62	16.2
Total nitrogen	13.3	133.
Oxygen absorbed in 4 hours	20.79	207.9
Chlorine	14.98	149.8
Suspended solids	36.6	366.

The Caterham Barracks figures were obtained from the average of four sets of hourly samples, and are even stronger:

	Parts per 100 000.	Parts per 1 000 000.
Ammoniacal nitrogen	31.41	314.1
Albumenoid nitrogen	1.75	17.5
Total organic nitrogen	3.87	38.7
Total nitrogen	17.53	175.3
Oxygen absorbed in 4 hours	17.99	179.9
Chlorine	13.57	135.7
Suspended solids	42.10	421.

* London, England.

† Received by the Secretary, July 21st, 1919.

Mr. Kershaw.

The sewage of Kingston-on-Thames may be regarded as an average domestic sewage, and the figures are also obtained from sets of hourly samples, drawn according to rate of flow:

	Parts per 100 000.	Parts per 1 000 000.
Ammoniacal nitrogen	3.85	38.5
Albumenoid nitrogen	0.86	8.6
Total organic nitrogen	1.63	16.3
Total nitrogen	5.49	54.9
Oxygen absorbed in 4 hours	10.66	106.6
Chlorine	9.43	94.3
Suspended solids	31.	310.

The foregoing figures demonstrate the strength in nitrogenous matter of camp sewages as compared with domestic sewages, and this is due no doubt to the fact that, as the author points out, the population is adult, and, further, the quantity of nitrogenous food consumed is large. The same thing has been observed in Great Britain, in the case of colliery towns and villages; in these cases, however, the water supply is often low.

During the first stage of the war, considerable difficulty was experienced here with grease, and specially large grease traps were put into use for intercepting it. Disinfectants, too, were often used in sufficient quantity to interfere materially with biological purification. Grease, however, was the chief difficulty, and, as might have been anticipated, it caused trouble at all stages of treatment, while it was some little time before steps were taken to utilize the grease recovered.

In the early stages of the war, many of the camp sewage treatment works left a great deal to be desired, both as regards design, and ability to cope with the very concentrated sewages. Moreover, in some instances, several small treatment works were constructed, where, with a little ordinary engineering skill, one plant would have sufficed.

In the camps in Great Britain, it was found that the sewage flow was almost invariably divided into distinct flushes, the flow being practically confined to about from 10 to 12 hours out of the 24. Consequently, when the filter capacity was calculated on the basis of the sewage flow of an ordinary town, at a rate of, say, 75 gal. per cu. yd. per 24 hours, it was about 50% too small. This fact was often lost sight of at first.

With respect to water supply per capita, the figures given by the military authorities were usually found to be much too low, and 30 gal. per head was determined as being about right, in fact, it was the usual figure taken for a town water supply.

With regard to manholes, it is the customary rule in England, that the distance apart shall not be in excess of about 300 ft. Some years ago, lampholes were permitted between the manholes, but, lately, they

Mr. Kershaw.

have been discouraged by the Local Government Board. In the case of the majority of the camps, full treatment by tanks and filters has been carried out, as conditions were seldom such as to warrant the discharge of tank liquors without further treatment.

The following details of a plant designed to deal with a total sewage flow of about 20 000 gal. per day, may be instructive, as showing that the treatment of a strong camp sewage is by no means a simple matter:

1. Grease trap.
2. Covered septic tank, capacity about 15 000 gal., with inverted pyramid bottom for removal of sludge.
3. Small mixing tank for chemicals.
4. Four fill and draw settling tanks, capacity of each about 5 000 gal., with floating arms and sludge valves.
5. Two dosing tanks, capacity of each about 200 gal.
6. Two deep percolating filters of coarse coke or clinker, capacity of each about 250 cu. yd., with automatic distributors.
7. Effluent settling tank, capacity about 2 000 gal., with inverted pyramid bottom for removal of humus.
8. General sludge sump, provided with chain-pump, and communicating with septic tank, settling tanks, and effluent settling tank.
9. Two shallow effluent straining filters of fine coke or clinker, each about 20 sq. yd. in area and 9 in. deep.
10. An area of land set aside for trenching the sludge, which would be considerable in volume.

This is a specification written by Maj. C. C. Frye, one of the chemists to the recent Royal Commission on Sewage Disposal.

The writer is unable to follow the author's statement that, "the capacity of a trickling filter does not vary directly with the volume of filtering material, a 5-ft. filter giving as good results as a deeper one." Surely this depends very largely on the size and character of the filtering material used; in other words, on the duration of contact of the liquor with the filtering material.

Comparison of the work done even by similar filters, with similar distribution, is beset with pitfalls. For example, a 5-ft. filter (*A*), may be working below its full power and producing a good effluent at a certain given rate of filtration per cubic yard; it would be erroneous to dose a 10-ft. filter (*B*), at a rate three times that of Filter *A*, and, because it produces an effluent similar to that of Filter *A*, to assume that Filter *B* can treat three times as much as Filter *A*, as Filter *A* is not working up to its full capacity; this destroys any comparison.

Concerning continuous and intermittent distribution on filters, it is to be observed that if the tank liquor is applied to filters not con-

tinuously, but in flushes, this must result—other things being equal—in increasing the volume treated per cubic yard in a given time. It would seem to be most desirable, in comparisons of treatment plants, to give the numerical figure of strength of sewage dealt with in each case. Mr. Kershaw.

AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications.

THE PROPOSED NEW YORK AND NEW JERSEY VEHICULAR TUNNEL

An Informal Discussion*

By E. E. R. Tratman, Assoc. M. Am. Soc. C. E.

Mr. Tratman.

E. E. R. Tratman,† Assoc. M. Am. Soc. C. E. (by letter).‡—With reference to the accommodation to be provided in the proposed Hudson River Tunnel for vehicular traffic, it appears to the writer that more attention should be given to that for pedestrians. Although no large amount of pedestrian traffic may be expected in a tunnel of such length, there are special conditions and emergencies to be considered. For instance, there is the possibility of a vehicle breakdown or blockade, causing passengers to leave cars or omnibuses and start to walk out of the tunnel. If a blockade should be attended by an accident, such as a collision or the burning of an automobile, there is the further possibility of a panic or a rush for escape. None of the plans appears to provide adequately for such contingencies.

In the proposed 31-ft. tunnel section, with two sidewalks on opposite sides of the upper deck roadway, the available width of these walks is limited materially by the overhead curve of the tunnel wall, as the sidewalk level is slightly above the center line of the tunnel. This would cause people instinctively or necessarily to keep near the curb. As a matter of fact, it does not seem that two people could walk side by side or pass each other without inconvenience.

In the Blackwall Tunnel under the Thames, at London, the sidewalk level is about 4 ft. below the center line, so that the tunnel wall curves outward from the walks and there is ample overhead clearance. This is also true of the Rotherhithe Tunnel, with its greater diameter

* Continued from May, 1919, *Proceedings*.

† Wheaton, Ill.

‡ Received by the Secretary, July 14th, 1919.

Mr. Tratman.

and greater width of sidewalks. It is not easy to understand the reason for the inner curb or footguard on the sidewalks, which forms a part of the lining in these two tunnels. It reduces the effective width by a few inches, although every available inch is desirable. In fact, the capacity and convenience of the walk might be increased by flattening the curve of the tunnel lining for the height of a few inches above the walk, thus increasing the actual width. This would not affect the strength of the tunnel.

In the proposed 42-ft. section for the Hudson River Tunnel, the single depressed footwalk appears to be inconvenient and inadequate, with the further objection that dust and dirt from the roadway are likely to be scattered over the pedestrians. The plan for a multiple-tube concrete tunnel also shows scant accommodation for pedestrians, although the designers note that details of the compartments can be varied to meet requirements.

Ventilation of the different levels and compartments will be a special problem in such a long tunnel having traffic composed largely of motor vehicles, and in which the vehicles will occupy so high a proportion of the cross-sectional area of the compartments. For instance, in one design the high-speed compartment has a headway of 9 ft., while the height of the highest vehicles is said to be 7 ft. 10 in. Dilution by forced draft would seem to be necessary, probably in combination with an exhaust or induced draft.

About a year ago, it was proposed to extend a street across a Chicago park by means of a tunnel, in order to avoid cutting the park by a surface thoroughfare. One question was in regard to ventilation conditions with a heavy traffic of motor vehicles. The writer made some inquiry as to conditions in the two Thames Tunnels at London, but the motor traffic was so slight, comparatively, that pollution of the atmosphere from that cause was a very small factor. Apparently, those tunnels have provision for artificial ventilation, but this is not in operation. Further, the cross-sectional area is much larger in proportion to that of the vehicles, than is the case in the proposed designs for the Hudson River Tunnel.

The double-deck tunnel idea is of particular interest to the writer for the reason that about 1890 or 1891 he undertook to suggest such an idea to the late Sir Benjamin Baker, Hon. M. Am. Soc. C. E., then Consulting Engineer for the proposed Blackwall Tunnel under the Thames. An oval section was proposed, with a diaphragm or upper deck for the roadway and a narrower bottom deck for pedestrians. Naturally, the reply was to the effect that for a tunnel in loose material nothing but a circular section could be considered. It may be noted, however, that railway tunnels of oval section in swelling and unstable material have been reinforced in some cases by steel ribs. This treatment, of course, was only designed to meet unexpected emergencies and

Mr. Tratman.

is not a criterion for tunnel design, while the railway tunnels in question were of much smaller section than would be required for a double-deck tunnel.

Supplementing the double-deck oval section, the writer suggested a circular tunnel having an upper deck supported on columns and not in contact with, or in any way connected to, the tunnel wall, thus avoiding any interference with distribution of stresses in the latter, due to external pressure. In other words, there was a viaduct within the tunnel. It should be explained that neither of these ideas ever attained the dignity of a serious study as to its possibility or practicability.

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AMERICAN HIGHWAYS

An Informal Discussion*

By H. F. Dunham, M. Am. Soc. C. E.

Mr. Dunham.

H. F. Dunham,† M. Am. Soc. C. E. (by letter).‡—The discussion on American Highways is full of interest and encouragement. The encouragement is obvious, and was to be expected, because many conditions are somewhat novel and, therefore, the pendulum is liable to pass the ordinary limit. When this occurs, it is natural to accelerate further instead of imposing restraint. It is more common and popular in any event.

A few lessons from the past should be cited and heeded. When it was shown conclusively that electric traction offered certain advantages in certain localities, scant regard was given to the fundamental rights of existing lines of steam transportation, or to the true interests of the general public. In that period of enthusiasm, it was held in some States that to permit an electric line to carry freight would be to treat unfairly a long established steam road in the same vicinity, and such permission was denied, not in a particular case, but in all cases. Thus, many electric lines that might have been valuable feeders to the steam roads and of great value in their districts were discouraged and not built. At the same time, steam roads between cities that had been almost created by those roads, were linked up, with little or no objection, by electric lines that are now in need of more passengers, higher fares, or new investors. The errors in the two methods thus presented, opposed alike to good morals and good legislation, have helped to impoverish the public, weaken all service, and introduce chronic troubles.

* Continued from May, 1919, *Proceedings*.

† New York City.

‡ Received by the Secretary, July 7th, 1919.

Mr. Dunham.

These are facts that should be examined and studied well before entering on an almost identical course following another change or advantage in the application of mechanical power. Had a different course been followed, and electric lines located and given rights where the best interests of all concerned demanded, the two systems might be working in harmony in many places throughout the country where serious difficulties now exist; and, further, a close approach to that more satisfactory condition could have been reached, if the demands of promoters had been limited by competent railway boards or public service commissions.

After this broad object lesson, and in the midst of further activities, the United States Government will not set aside funds to be used in the improvement of a highway unless that highway is now "a post road", while it is notorious that post roads, especially in New England, were located over summits nearly as high as could be found. At the present time, and for this reason, improvements are made following bad locations and the most difficult grades. First, there should be better co-operation between Federal, State, county, and municipal authorities. Labor interests should be included, but it may be questioned whether wrong labor activities, that is, wrongly or badly planned, should lead to extended new construction, even if such new departures would require the employment of many workers. Recently, we have seen that mere numbers are not an effective safeguard against injury to all classes. Parts of the United States and provinces in Canada and Russia show this. Where a weak link exists because of active corrosion, it is better to safeguard the weak place than to add elsewhere to surfaces that must be exposed to the same acid influence. Engineering would soon be a synonym for impoverishment if wrong deeds always insured new and extended construction. One may question and doubt whether engineers should encourage larger factors of safety, because of political unrest among American workmen.

In electric road construction, it was generally intended that the cost of right of way, construction, and equipment should be covered by bond issues. The stock became valuable from earnings in excess of interest and operation charges. Profits increased as maintenance, equipment, and depreciation were neglected. Often the roads were left in the possession of the bondholders to be operated or abandoned. All this was individual or business enterprise, where bad judgment, want of foresight, or too great enthusiasm brought discomfort.

Now, however, in the new adventure, where the rights of way and the roadbed are owned by the public and, of necessity, kept in some kind of condition by that public, complications are increased immensely. The Ford automobile and the heavy truck have practically equal rights. The light rig and the locomotive are on the same roadbed

without rails, and both look to the public for support and safety. A requirement of one is that no special diversion of rainfall shall occur at intervals on high grades. An evil of the other is a groove in the roadbed that becomes a destructive river in every hard storm. The public makes repairs. Where the ground is soft, the heavy truck depresses the roadbed. The public brings the surface up to grade. Deep freezing and thawing make radical changes in the surface. The public attends to that. In winter, drifting snows bury fences and fill up the cuts. The public opens the way without the aid of a snow plow. Mr. Dunham.

It seems worthy of remark that in a discussion on highways in a State the latitude of which is 42°, and where the snowfall is exceptional, not a word was said bearing on snow blockades or the expense of keeping a bridle path open in weather that closes up the Hudson River. The only reason for this must have been the confidence engineers share in the assistance to be derived from the public. We know what has been done under the stress of war, when long trains of trucks were brought through deep drifts in the mountains. We seem to think a similar service can be maintained at public expense.

In reaching out, however, into districts not occupied by railroads, it should be remembered that throughout a large part of the United States winter service must be abandoned above the snow line, and for no small part of the year the equipment is idle. To that extent this method of transportation suffers in comparison with railroads.

On steam roads in this country, freight is now moved at an average cost of not far from 2 cts. per ton-mile, and it is on such figures that determinations of profit and loss are made. Back of the actual rate, whatever it may be, there are years of operation with accounts that disclose almost every item of expense. How much is accurately known of the cost of hauling by motor truck per ton-mile over roadways provided and kept in repair by the public? Repairs to the trucks at this date are usually made by the owners.

In Massachusetts, steam road and highway automobile accidents are not returned under exactly similar headings. The Commission gives the number of passengers killed and a detailed account of accidents to employees on steam roads. It is not difficult, however, to determine how many employees are killed by trains in motion, and, in this way, to make fairly accurate comparison with the record of "Occupants of Automobiles."

Thus, in 1918, in that State, 33 persons (13 passengers and 20 employees) were killed on steam roads. Of occupants of automobiles 136 were killed. The totals for the year may be thought to be more surprising: Steam roads, killed 247 (including 98 trespassers, not on grade crossings), injured, 137; killed by automobiles, including motorcycles

Mr. Dunham.

and motor trucks, 499, injured, 8 598. These figures show a phase in transportation which cannot be disregarded in highway discussion and should be remembered when it is sought to change a steam road branch to a highway.

These losses in life, time, crippled limbs, and cost of recovery may not be classified in any particular schedule, but they are very real and are losses on the community balance sheet in any final auditing, which are and always will be on the wrong side.

MEMOIRS OF DECEASED MEMBERS

NOTE.—Memoirs will be reproduced in the volumes of *Transactions*. Any information which will amplify the records as here printed, or correct any errors, should be forwarded to the Secretary prior to the final publication.

OWEN BRAINARD, M. Am. Soc. C. E.*

DIED APRIL 2D, 1919.

Owen Brainard, well known as an architectural and civil engineer, and for many years an associate of the firm of Carrere and Hastings, died suddenly of heart stroke on April 2d, 1919, in New York City.

Owen Brainard was the son of Hubert Brainard and Cynthia Virginia Brainard, and was born on March 10th, 1865. He was descended from the first Brainard who came to the Massachusetts Bay Colony in 1642, and who was among the original proprietors of the Town of Haddam, Conn. His family has been prominent in the affairs of Middlesex County, Connecticut, through several generations, his father, grandfather, and great-grandfather having been members of the Assembly. He received his early education in the local school. Mathematics and history were his favorite studies, and he built on this foundation, by technical reading and hard study in preparation, his professional activities, also receiving instruction from professors of New York University and Stevens Institute of Technology. With an alert, inquiring, and retentive mind, he fitted himself through this study to be one of the leading men of his profession. He had the rare good fortune to choose a field of work which was a source of great satisfaction and interest to him.

Owen Brainard's father was famous in his neighborhood for his skill in masonry building, for his familiarity with mechanical appliances, and his common sense, and as a boy the son learned the practical side of his future work. In his later life, he found this early knowledge of great assistance. In a machine shop in Higganum, Conn., he learned the art of work in metals. From there he went to Philadelphia, Pa., where he lived in Germantown for a number of years.

In 1890 Mr. Brainard returned to Higganum, and there designed and built a church and several houses, one of which was of some distinction. Through these various commissions he was enabled to go abroad for study. On his return he sought New York City as a field in which to practice his profession, and his first effort was in the application of terra cotta to modern steel construction. In 1893,

* Memoir prepared by Thomas Hastings, Esq.

shortly after coming to New York, he secured the position of Engineer with the firm of Carrere and Hastings, and continued in it until his death.

Mr. Brainard's application to his work was practical. He stood for usefulness, endurance, and honesty of structure. He had a keen interest in and understanding of materials and processes of manufacture, which especially fitted him for the position of architectural engineer.

Through the large and very general practice of Carrere and Hastings, Mr. Brainard was associated with the construction of some of the most notable and important buildings in the United States. He was retained also on the general supervision and structural design of the Cuyahoga County Court House in Cleveland, Ohio, and several large churches in the West.

Mr. Brainard was the Consulting Engineer for the United States Steel Corporation in the development of several of its large towns, and was engaged during the war in the planning of Camp Meade, and the planning and building of the Workmen's Hotels at Hog Island, Pa., for the Emergency Fleet Corporation. In later years, he had become greatly interested in large sanitation and housing problems, and, at the time of his death, he was looking forward to the study of the needs of the modern city in sanitation and planning.

On his first visit to Europe, Mr. Brainard made a study of lighthouse problems, and he was consulted by the Diamond Shoal Lighthouse Commission when the construction of that lighthouse was projected.

In 1901, Mr. Brainard was made an associate in the firm of Carrere and Hastings, and this connection continued for a number of years, until the larger development of his personal practice. However, his professional connection with the office continued until his death.

He was a member of the Engineers' Club, the Architectural League, the American Institute of Architects, and the City Planning Association. He was also a member of the Century Club, the Apawamis Club of Rye, N. Y., and the Mastigouche Fish and Game Club of Canada.

Mr. Brainard had many charming business and social qualities, and was looked up to and admired by all with whom he came in contact. Those who knew him and consulted him always retained a high regard for his clear-sighted analysis of conditions, his high standard of fair dealing, and his integrity and tactful treatment, whatever the circumstances under which the questions were submitted to him, or whatever the conclusions reached in the problem dealt with. His brevity and conciseness in expressing his conclusions gave judicial character to his technical mastery of his subject.

His recreation was in fishing and golf. He had an excellent sense of humor, and great aptness in the application of a fitting story to the question under discussion. Mr. Brainard gave much of his spare time to reading. He was an earnest worker, never neglecting his duties, and an active participant in the work of the several professional societies to which he belonged.

On March 10th, 1909, he was married to Jean Sawyer, and made his home in New York City. He had lately built a summer home at Riverside, Conn. Besides his wife, he is survived by two brothers, Daniel and Harrison Brainard, and one sister, Ursula Brainard, who live at the old home in Higganum.

Mr. Brainard was elected a member of the American Society of Civil Engineers on October 3d, 1906.

JOHN STERLING DEANS, M. Am. Soc. C. E.*

DIED DECEMBER 16TH, 1918.

John Sterling Deans was born at Chester, Pa., on June 25th, 1858, and received his early education in the schools of that place. His father, Charles Woodbury Deans, was engaged in educational work and did much in the early organization of the common school system of the State and in providing school facilities for the orphans of Civil War soldiers. His mother, who survives him, was Priscilla Lyons Williams, of Chester.

The death of his father left Mr. Deans, the eldest of four children, with serious responsibilities early in life, and at the age of 20 years he left the Philadelphia Polytechnic College, before graduation, and took up his life work in his chosen profession.

His first employment was with Clark, Reeves and Company, of Phœnixville, Pa., in January, 1879, at which time this firm was building a large part of the elevated railroad structure in New York City; and, during his subsequent connection with this firm, which afterward became the Phœnix Bridge Company, he saw the development of the modern long-span railroad bridge from the early iron structures that were built during the era of railroad construction which followed the Civil War.

Many noted structures, such as the old Kinzua Viaduct, and the Albany and Greenbush Bridge over the Hudson River, with which Mr. Deans was connected at the outset of his career, were built by the above firm. These were followed by the Red Rock Cantilever Bridge,

* Memoir prepared by Howard C. Baird and Walter R. Okeson, Members, Am. Soc. C. E.

the Pecos Viaduct, the Rock Island Bridge, the Huntington Bridge, and many others, with which he was connected in various engineering capacities.

Mr. Deans assisted in the design of the Chesapeake and Ohio Railroad Bridge, known as the Huntington Bridge, over the Ohio River at Cincinnati, Ohio, had entire charge of the work in the drawing room, and afterward became Resident Engineer during the erection of the structure, in 1888-89.

This bridge, at the time it was built, contained the longest simple truss span in existence, was double-tracked throughout, with double roadways and sidewalks, and marked an epoch in railroad bridge construction. After the successful completion of this work by the Phœnix Bridge Company, Mr. Deans became Engineer of Erection for the Company, then, in 1891, Principal Assistant Engineer, and, a year later, Chief Engineer. During the time he held this office, a number of large and important bridge structures were built under his direction, many of them being designed by the Company and most of them erected by its Erection Department, in which Mr. Deans took great pride and which he brought to a high state of development. The Rock Island Bridge at Davenport, Iowa, the Big Four Bridge at Louisville, Ky., the Cambridge Bridge at Boston, Mass., the steelwork for the Manhattan Bridge over the East River, New York City, and the bridges at Sioux City and Omaha, Nebr., with their long draw-spans, were among the large number of structures erected under his supervision.

He became Vice-President of the Phœnix Bridge Company in 1915, and, in 1917, Vice-President and Consulting Engineer.

As a young man, Mr. Deans' work was marked by extreme care and conscientiousness. His optimistic spirit endeared him to all his associates, and in fact to every one who came in contact with him, and inspired many a beginner to look on the bright side of life and take courage from his example. His fine character and lovable personality had their effect in a marked degree on the young men who came under his authority while he was in command, and all who ever served him treasured the memory of his friendship with an affection equal to their great admiration for his character.

About two years before his death, his health began to fail, and, except for several short periods of apparent improvement, the decline was slow, but sure. In spite of his declining health, however, Mr. Deans was as energetic as ever, and gave unfailing attention to the many duties devolving upon him, undertaking in December, 1917, the work of Chairman of the Steel Fabricators of the United States, an association devoted to aiding the United States Government and the industry in war work. His health continued to decline until the end came, on December 16th, 1918. His youthful spirit and courage remained

with him to the last, and the patience which he exhibited during his tedious illness and suffering emphasized the perfect unselfishness that marked his life.

In 1890, Mr. Deans was married to Miss Clara V. Barr, of Cincinnati, Ohio, who survives him. He is also survived by his mother, two sisters, and four children, his two sons having served in the United States Army during the war.

Mr. Deans was elected a Member of the American Society of Civil Engineers on May 4th, 1887.

RUFUS CAMERON HUNT, M. Am. Soc. C. E.*

Died February 18th, 1919.

Rufus Cameron Hunt was born at Bowling Green, Ky., on December 1st, 1851. His father was a farmer and long a resident of the State. His early education was obtained at a local school kept by a Professor Shields. Without the advantage of a college education, he taught himself the rudiments of engineering and began his life's work in railway location and construction—a great field, but one from which only the efficient rise to prominence or a competence.

In 1898 Mr. Hunt was a Division Engineer on the construction of a railway in Maine without apparent prospects, but his careful, conscientious work had attracted the attention of those who are always on the lookout for capable men. In that year the Bryce Syndicate was organized, under the name of the American China Development Company, for the construction of railways in China, and Mr. Hunt was offered a position as Assistant Engineer. Later, he was made Locating Engineer, and had charge of the survey from Hankow to Canton, 750 miles. Part of the line has been constructed, as laid out by him. He remained in China for some time as Chief Engineer. From China, Mr. Hunt went to Europe, and thence for more than a year to South America where he had charge of important work in the Andes Mountains and Peru. His next field was Mexico.

In the meanwhile, the subway in New York City was under construction, and the contractor who had charge of the Fort Washington Tunnel, from 160th to 196th Streets, had become so much involved that the bonding company had to take over the work. As the result of a conference between the Company, the General Contractor, and the Chief Engineer of the Commission, Mr. Hunt was selected to take charge of this highly important and difficult section. So well did he carry out his trust, that Mr. John B. McDonald subsequently placed him in charge of the Jerome Park Reservoir contract. Then followed other large pieces of

* Memoir prepared by William Barclay Parsons, M. Am. Soc. C. E.

contract work, but, on their completion, Mr. Hunt decided to retire from the field where he had succeeded so well and take up the life of his forefathers, that of a country gentleman. To this end, he acquired an extensive farm near Washington Court House, in Fayette County, Ohio, with which he had the same success as he had building railways or digging tunnels. He died at his home on February 18th, 1919, of pneumonia following an attack of influenza. He is survived by his widow, who was Miss Lida Saxton.

His character was like his mind and frame, rugged and strong. It was marked by a rare combination of firmness and justice, but, if any one quality predominated, it was unwavering loyalty. He loved truth, hated shams, and was a fine specimen of a real American. These qualities endeared him to all. As an engineer he had sound judgment which, combined with his personal traits, made him a real leader of men.

Mr. Hunt was elected a Member of the American Society of Civil Engineers on October 5th, 1904.

JOHN CHRISTIAN OSTRUP, M. Am. Soc. C. E.*

DIED FEBRUARY 27TH, 1919.

John Christian Ostrup was born on an estate near Frederickshaven, Denmark, on August 31st, 1867. He received his early education at a private school in Frederickshaven and his principal technical training, including thorough military instruction, at the Royal Danish Military Academy, from which institution he was graduated in 1888. He remained in the Danish Army as Lieutenant for two or three years.

In 1891 Mr. Ostrup came to the United States and immediately supplemented his technical education by night work at an engineering school in Chicago, Ill., mainly for the purpose of learning English technical terms. He was graduated from that school in 1892. After obtaining his degree there, he engaged in various enterprises in different parts of the United States, beginning with the design of the Machinery Building for the Chicago World's Fair, and afterward including much work with the writer, first, on the Northwestern Elevated, Union Loop Elevated, and Lake Street Elevated Railroads, of Chicago, and, later, on the Elevated Railroad of Boston, Mass. On these vast enterprises he did effective and important work and held responsible positions. At first, his chief occupation was in the field, but, later, he did considerable structural steel designing, especially for the Boston Elevated, including the entire design of its great terminal building. On the completion of the latter, Mr. Ostrup spent a few years in private

* Memoir prepared by J. A. L. Waddell, M. Am. Soc. C. E.

practice, mainly in the designing of power houses, industrial plants, etc., and the sheds to contain them; he then entered the employ of the American Bridge Company, where he remained for several years. While with that organization, he detailed, among other structures, the Manhattan Bridge.

From 1907 to 1911 he was Professor of Structural Engineering at Stevens Institute of Technology, Hoboken, N. J., giving there a most successful and popular course, notwithstanding the fact that he was handling a civil engineering department in a mechanical engineering school. It was at that time that he wrote and issued his excellent book, known to the Profession as "Ostrup's Specifications," which deals with methods of modern engineering. It has been widely used in military academies throughout the country, including West Point.

After four years' service at teaching, Mr. Ostrup resigned his position as Professor at Stevens Institute to take that of Chief Engineer to the Texas Company, with headquarters in New York City; and he handled with phenomenal success all the important engineering problems of the vast and diversified business of that company until it appeared probable that the United States would enter the war, when he at once tendered his services to the Government of the land of his adoption. Having been thoroughly trained in military engineering in Denmark, his offer was gladly accepted, and he was given the rank of Major early in January, 1917. He sailed for France that year with the first detachment of the American Expeditionary Force, following General Pershing, to whose staff he had been assigned as an expert on engineering. During the war Maj. Ostrup saw continuous service at various points along the entire western front, his special duties being the supervision of the building of trench fortifications and bridges, where his knowledge of concrete construction proved of great value. In fact, he showed such unusual ability that, after a year at the front, he was returned to the United States to instruct new officers in the principles and practice of modern warfare. He continued his work as Instructor until after the declaration of the Armistice, when he tendered his resignation and asked for its speedy acceptance. He was urged to remain permanently in the United States Army, but refused, owing to ill health caused by over-work and an attack of influenza contracted while in France and from which he had never fully recovered. As soon as he was released from the Army, he returned to his old position with the Texas Company and resumed his former work.

On February 19th, 1919, Maj. Ostrup took lunch with the writer, and spent the better part of two hours in discussing his experiences abroad. It appears that, although often under fire, he was never wounded, although once his clothing was torn by a piece of shrapnel. His description of his work "over there" and of life in the trenches

was intensely interesting, especially as he and the writer had been close friends for more than a quarter of a century. Among other things he mentioned the fact that, owing to the great amount of business done by the Texas Company during the war, his stock therein had brought such big returns as to render him independent for the rest of his life, and he was seriously considering retiring soon from active practice—but, alas! it was not to be; for that very evening he was stricken with influenza, which soon turned into pneumonia, to which he succumbed a week later.

Maj. Ostrup was a man of strong personality, an accomplished linguist, speaking several languages fluently and well, and having a reading knowledge of others, a deep student of applied science as well as of economics and the humanities, a good technical writer, an engineer of high attainments, a military officer of courage and of unusual ability, an accomplished musician, a true and loyal friend, and a thorough gentleman. In his premature death the Engineering Profession has sustained a real loss, and many members thereof have suffered a bereavement which will long be remembered.

Maj. Ostrup was elected an Associate Member of the American Society of Civil Engineers on March 4th, 1896, and a Member on March 1st, 1899.

JOHN WARREN SACKETT, M. Am. Soc. C. E.*

DIED JULY 3d, 1918.

John Warren Sackett was born at Rantoul, Ill., on December 13th, 1860. He received his elementary education at that place, and when he was 14 years old, he had been graduated from the High School and had passed the entrance examinations to the University of Illinois. He was prohibited from entering at that time, however, by reason of the age limit—15 years—in force there. In 1876 he became a student in the Civil Engineering Department of the University where he remained for two years. He also took manual training in carpentry and machine work.

In 1877 and 1878, Mr. Sackett taught school, with the intention of completing his college course, but his father, who had moved to Florida and was engaged in contracting and building, required his services in his business. In this connection Mr. Sackett made architectural drawings and superintended construction work, as well as operating a saw-mill. In the meantime, he continued his engineering studies under J. Francis LeBaron, M. Am. Soc. C. E., by whom he was engaged in land and railroad surveying and in the operation of a short line of

* Memoir prepared by the Secretary from information furnished by J. Francis LeBaron, M. Am. Soc. C. E., and on file at the Headquarters of the Society.

railroad, as well as on Government surveys of various canals, rivers, and harbors in Florida.

On May 16th, 1881, Mr. Sackett was appointed an Assistant Engineer in the United States Engineer Corps, by the late Col. Q. A. Gillmore, Corps of Engineers, U. S. A., M. Am. Soc. C. E., on the recommendation of Mr. LeBaron, U. S. Assistant Engineer, under whom he was serving, and was identified with that organization for more than thirty-five years, as follows:

May and June, 1881, he served as Recorder in the party of Mr. Le Baron, under whose immediate direction he remained, until 1886, on the survey for a canal route from the head-waters of the St. Johns River to Charlotte Harbor, Florida; December, 1881, and January, 1882, he was engaged as Inspector on jetty work at Cumberland Sound, Georgia, and Florida; about this time he entered a competitive examination for appointment to West Point Military Academy and had been recommended for entrance, but owing to political reasons, the appointment was not granted; until the fall of 1883, he was Inspector of jetty work at the entrance to St. Johns River, Florida; until the spring of 1884, he was engaged as Instrumentman on a survey of the Savannah River; in 1885, he made a survey and plans for a Marginal Railroad in Jacksonville, Fla., under the direction of Mr. LeBaron, Chief Engineer, and surveyed and platted several town sites; he also served, until May, 1885, as Chief Draftsman in the Surveyor-General's Office at Tallahassee, Fla.; until February, 1886, he was Superintendent and Draftsman, under Capt. William T. Rossell, Corps of Engineers, U. S. A., on dredging and rock excavation at Tampa and Cedar Keys, Fla., and in the spring of the same year, he served as Assistant, under Capt., now Maj.-Gen., William M. Black, Corps of Engineers, U. S. A., M. Am. Soc. C. E., on the survey at the entrance to St. Johns River, Florida; and from that time until 1888, he was engaged as Assistant Engineer in charge of the survey at the northwest entrance at Key West Harbor, Florida, and of a survey of the Caloosahatchee River.

In 1888, Mr. Sackett was made Principal Assistant Engineer of the Florida District, and given general supervision of the details of the work in that District under the direction of the District Engineer Officer, continuing in that position until his sudden death on July 3d, 1918, his title having been changed in 1917 to that of Chief Assistant Engineer of the Florida District of the U. S. Engineer Department. His work as Principal and Chief Assistant Engineer of the District consisted in preparing plans, projects, estimates, reports, etc., for submission to the Chief of Engineers, as well as the detailed design construction, operation, maintenance, etc., of all the floating plant, such as hydraulic dredges, steam and power plants, hyacinth elevators, etc. In connection with this work, he had introduced many novel improvements in successful operation, on several of which patents have been issued.

While a student at the University of Illinois in 1876-77, Mr. Sackett had received some military training, and, in 1895, he was commissioned as Captain of Co. G, 1st Florida Infantry, known as the St. Augustine Rifles. When war with Spain was declared in 1898, Capt. Sackett was promoted to be Major in the 1st Florida U. S. Volunteer Infantry, but was afterward detached from that regiment and placed in command of a Provisional Engineer Battalion formed by details from Florida and Illinois troops. After training for about six weeks at Port Tampa, Fla., Maj. Sackett left there with the Battalion and arrived at Santiago, Cuba, the day following the surrender of the Spanish Forces. After some construction work at Guantanamo Harbor, the Battalion joined the Porto Rican Expedition and led the landing party at Guanico on July 25th, 1898, under fire, with Maj. Sackett in command of the right wing. For this action and for soldierly qualities displayed on the night of July 26th-27th, 1898, when on outpost duty, he received the brevet rank of Lieutenant Colonel, U. S. Volunteers, "for coolness under fire and efficient and meritorious services during the war."

Maj. Sackett remained with the Battalion until it was disbanded in New York City in September, 1898. He was not mustered out of service, however, until January, 1899, having been placed in command of a battalion of a Florida Regiment stationed at Huntsville, Ala., where he acted as Brigade Commander for a time, although only ranking as Major.

The following is an extract from the report of Col. Black, Chief Engineer, U. S. Volunteers, to the Adjutant General of the Army, dated August 22d, 1898, regarding the operations of the Battalion:

"For the drill, discipline and spirit, much credit is due the officers of the battalion, among whom discrimination cannot be made, excepting it be for the commanding officer, Major J. W. Sackett, 1st Fla. Vols., whom I have known for years as a valued civil engineer employee of the United States. It is but fair for me to say that, without his aid, I do not know how I could have performed the duties allotted to the Engineer force of the expedition."

After the war he rejoined the Florida Militia as Captain and was promoted through the various ranks until he was commissioned as Brigadier General of the Florida National Guard, on February 28th, 1906. Gen Sackett was retired on February 22d, 1907, at his own request, due to press of work with the U. S. Engineer Department. During his service with the Florida Militia, he was a member of the Commission appointed to select a permanent camp site, personally located the site subsequently adopted by the State authorities, and until his death served on the Board which had charge of the grounds. He also supervised all the surveying and engineering work in connection with the development of the camp and target range, and prepared plans and estimates for its enlargement, water supply, etc. In 1917, when the United States entered the European war, Gen. Sackett

immediately offered his services to the Adjutant General, U. S. Army, in any military capacity that would be useful.

On July 1st, 1918, in the line of duty, Gen. Sackett left St. Lucie Inlet, Fla., on board the dredge *Florida* bound for Jacksonville, where the boat was to be used in dredging operations at Camp Joseph E. Johnston then under construction. On the trip up the coast the dredge encountered a heavy gale. One of the bulkheads was stove in by a heavy wave on July 3d, 1918, and the *Florida* filled and sank within three minutes. Gen. Sackett, who was in the cabin on the upper deck at the time and, it is supposed, did not realize the danger, and two of the crew, perished with the boat. He is survived by his widow and two sons, Arthur J. Sackett, Assoc. M. Am. Soc. C. E., and Guy W. Sackett.

Gen. Sackett was one of the best known and most popular men in Government work and military circles in Florida. He was held in high esteem by all who knew him, and his untimely death was a shock to his many associates and friends who were numbered by his acquaintances.

In the course of thirty years or more of service with the U. S. Engineer Department, he had been called on to investigate, discuss, and make out in technical detail and report on hydrographical and topographical surveys, watersheds, run-off, stream flow, tidal currents, wave action, jetties, breakwaters, locks, etc. For the purpose of observation and study, he had visited the Panama Canal during its construction. He had also visited Havana, Cuba, for the purpose of observing the raising of the wreck of the U. S. S. *Maine,* as well as other works of improvement affecting waterways, drainage, and reclamation work throughout the United States.

As shown by his military record, Gen. Sackett had been identified with the Florida State Militia for many years, and was Past Department Commander of the United Spanish War Veterans, Department of Florida. He was also prominent in Masonic and Elk circles, and other fraternal organizations.

Gen. Sackett was elected a Member of the American Society of Civil Engineers on May 2d, 1894.

NAOJI SHIRAISHI, M. Am. Soc. C. E.*

DIED FEBRUARY 17TH, 1919.

Naoji Shiraishi was born at Tochi, a village in Kochi Prefecture, Japan, on October 29th, 1857. When he was in his teens, Japan was passing through the crisis preceding the Restoration of the Imperial Rule, and in those days there was more call for the arts of war than

* Memoir prepared by J. Hiroi, M. Am. Soc. C. E.

for those of peace. He early showed his far-sightedness in applying himself to the study of European languages, in utter disregard of the general cry for the need of warlike training for boys of his age. In 1870 he went to Yokohama and studied English under the Rev. S. R. Brown. In 1875 he entered the Kaisei Gakko, the predecessor of the present Tokyo Imperial University, for the study of Civil Engineering, and was graduated from that institution in July, 1881.

In 1883 he was sent by the Government to the United States to complete his study in that branch of knowledge. Entering Rensselaer Polytechnic Institute, he studied mostly under Wm. H. Burr, M. Am. Soc. C. E. When Professor Burr took service with the Phœnix Bridge Company, Mr. Shiraishi accompanied him and was cordially given the freedom of both office and works to make a special study of bridge construction. He was deeply influenced by the personality and erudition of Professor Burr, and an intimate friendship grew up between the two men. Later, Mr. Shiraishi entered the service of the Pennsylvania Railway Company, to acquaint himself with the practice of railway engineering. Subsequently, he left America for Germany, and, while staying in Berlin, attended the lectures of Professor Winkler, in the Technische Hochschule in that city.

Returning to Japan in 1887, from a tour through the various countries of Europe, Mr. Shiraishi was appointed a Professor in the College of Engineering of Tokyo University. While holding that position, he acted as an adviser to the then organized Kansai Railway Company, in the location and construction of its lines. In those early days of railway construction in Japan, when the lines in operation in the country totaled not more than 1 000 miles, the services of expert engineers were not easily obtainable. The difficult nature of the work on the Kansai Railway having required the exercise of the highest technical knowledge, Mr. Shiraishi was called from his academic chair to give his undivided attention to the task, and, on his resignation of the professorship, in 1890, he was made the first President and Chief Engineer of the Company. As Chief Engineer, he gathered around him, as his assistants, many of his former pupils at the University, and carried to a successful issue one of the most difficult railway works in the country. This achievement had far-reaching consequences, in that those young men whom he had trained in the classroom and in the field went forth as competent engineers and distinguished themselves in various works of importance with which they were entrusted later.

In 1891 he had conferred on him the degree of Kogaku Hakushi, the title of the highest academic honor in Japan for the profession. In 1898, he resigned his position with the Kansai Railway Company, the construction work of the latter having been completed.

In 1899 Mr. Shiraishi was appointed a member of the Railway Council, the highest advisory board for discussing matters relating to the railway systems in Japan. In the same year, at the request of the Kyushu Railway Company—another company in which he was interested—he again visited Europe and America to make investigations of the methods of shipping coal in those countries. He selected the Brown coal hoist, as the one best fulfilling the requirements of the Company, and, having made a purchase of three machines, each of 5 000 tons capacity, erected them at the terminal yard of the Company.

In 1910 he was made President of the Wakamatsu Harbor Improvement Company, and continued in that position for nine years, during which time he carried out the construction of breakwaters and quay walls, and extensive dredging of the harbor. Under his able guidance, the harbor has become the most important coaling port in Japan, the quantity of coal annually seeking outlet at the port reaching 7 000 000 tons. Along the shore of the harbor stand the Government Steel Works and other large factories, and the busy shipping traffic has transformed the waste flat of former years into an excellent harbor, crowded with sailing ships and steamers.

At about that time, Mr. Shiraishi acted also as Consulting Engineer to the Mitsubishi Company, and designed and constructed breakwaters, quay walls, metallic piers, warehouses of reinforced concrete, dry docks, etc., for that Company at Nagasaki and Kobe. The 7 000-ton floating dock built at the Kobe Shipyard and the use of caisson blocks of reinforced concrete for the breakwaters and quay walls there, were the first engineering feats of the kind in Japan.

In 1907, at the request of the Corean Government, he planned a system of railway lines in the southwestern part of the Peninsula. The present lines between Taiden, Gunzan, and Moppo are substantially the realization of his plans.

From 1911 to 1919 Mr. Shiraishi was Managing Director of the Inawashiro Hydro-Electric Power Company, which has for its work the utilization of the waters of Lake Inawashiro, 140 miles from Tokyo, for the development of electric power. The lake is 44 sq. miles in area and is 1 000 ft. above sea level. An average volume of water of 840 cu. ft. per sec. is now utilized, in two stages, producing electric power aggregating 92 000 h. p., which is transmitted to Tokyo at a pressure of 115 000 volts. The works are now being enlarged by utilizing the tail-water, so that before long the total output will amount to 130 000 h. p.

Mr. Shiraishi was married in 1882 to Miss Kikuko, a daughter of Mr. Tsuna Takenouchi, a prominent financier. He is survived by his widow and two sons. The elder of these sons follows his father's profession as a civil engineer, and the younger is an electrical engineer.

It is the lot of but few men to be able to accomplish so much in life as Mr. Shiraishi. His practice covered almost all branches of civil engineering, and the works in which he was engaged were of such magnitude as has scarcely been equalled by any in Japan.

Mr. Shiraishi will long be remembered, not only for his achievements as an engineer, but also for his personal qualities. His admirable character made him popular with all who came in contact with him. Although he was not a professed Christian, he was so much inclined to that belief that his interment was made according to its rites.

Mr. Shiraishi was a Member of the Institution of Civil Engineers of Great Britain. In January, 1919, he was elected President of the Japan Society of Civil Engineers. Beside being an engineer of the foremost rank, he was no less a politician, having occupied a seat in the House of Representatives of the Imperial Diet, to which he had been returned three times, and, as a member of the Seiyukai party, was a prominent figure in political circles.

Mr. Shiraishi was elected a Member of the American Society of Civil Engineers on October 4th, 1899.

EDWIN JAMES POTTER, Assoc. M. Am. Soc. C. E.*

DIED OCTOBER 18TH, 1918.

Edwin James Potter, the son of Charles F. and Lenora E. (Sayles) Potter, was born in Bridgeton, R. I., on March 17th, 1884. He attended the graded schools of Burrillville, R. I., and was graduated from the Moses Brown School, of Providence, R. I. He took the civil engineering course at Brown University, and received the degree of Bachelor of Science in Civil Engineering in 1907.

During the summer of 1906, Mr. Potter was an Assistant in the office of the City Engineer of Providence, and in June and July, 1907, he was engaged on surveys and drawings for a mile of Macadam road for Burrillville.

In August, 1907, he entered the employ of the B. F. Smith Construction Company, Mill Builders and General Contractors, of Pawtucket, R. I., and for several years thereafter was engaged in estimating, drafting, laying out, and superintending the construction of mills, power plants, storehouses, etc., in New England and New York State.

Mr. Potter's interest in matters relating to engineering was keen, and he lost no opportunity to increase his knowledge of his profession. With this object, he visited the Canal Zone, in order to inspect the Panama Canal before its completion, as well as many other engineering works.

* Memoir prepared by the Secretary from information on file at the Headquarters of the Society.

In October, 1913, he took charge of the Hopkins Machine Works, in Bridgeton, and, under his management, the company prospered and increased its business. This concern had been owned by Mr. Potter's family for generations. It was founded by Augustus Hopkins, his great-grandfather in 1836, and from him it went to Mr. Potter's great-uncle, Horatio Hopkins. His grandfather, James Potter, was connected with the company, and his father, also.

Mr. Potter took a keen interest in everything that would be beneficial to the town, and could be relied on to lend a helping hand in any movement for its betterment.

He was a member and Secretary of Pascoag Hose Company No. 2, Past-President of the Alumni Association of the Burrillville High School and of the Moses Brown Alumni Association, and a member of Sigma Chi of Brown University. In all patriotic affairs in this district, he was an active worker, having served as a member of the Liberty Loan Committee and as Chairman of the Burrillville Committee in the War Savings Stamps drive.

Mr. Potter was a Republican, but did not take an active part in political affairs until 1918, when, after considerable urging, he consented to accept the nomination for State Senator.

He was very much interested in the welfare of the Free Baptist Church, of Pascoag, R. I., and, although he had never united with the church, he had contributed liberally toward its support.

He contracted influenza and died, after a two weeks' illness, at the home of his parents. His death was a shock to the community in which his life had been spent, and a distinct loss to the town. Besides his parents, he is survived by a sister, Mrs. Charles L. Osler, of Malden, Mass., who, shortly after her brother's death, moved to Bridgeton, R. I.

Mr. Potter was elected a Junior of the American Society of Civil Engineers on October 1st, 1907, and an Associate Member on October 1st, 1913.

DONALD POWER DENHAM, Jun. Am. Soc. C. E.*

DIED OCTOBER 23d, 1918.

Donald Power Denham, the son of Mr. and Mrs. W. H. Denham, was born at Akron, Ohio, on June 14th, 1890. In 1904, the family moved to Peterborough, Ont., Canada, and the boy prepared for college at the Peterborough Collegiate Institute. In 1910, he entered Cornell University, from which he was graduated in 1914 with the degree of Civil Engineer.

* Memoir prepared by the Secretary from information on file at the Headquarters of the Society.

In April, 1915, Mr. Denham entered the employ of the Leonard Construction Company, and was engaged on work for that Company as follows: Until April, 1916, as Field Engineer on the construction of a reinforced concrete ore bin and a reinforced concrete steel mill building for the New Jersey Zinc Company, at Franklin, N. J.; from April to October, 1916, as Resident Engineer on the construction of a garbage plant for the Metropolitan By-Products Company, on Staten Island, New York; and from October to December, 1916, on the construction of a reinforced concrete building for the Douglas Starch Company, at Cedar Rapids, Iowa.

In December, 1916, Mr. Denham's services were loaned by the Leonard Construction Company to the Quaker Oats Company for special drafting and designing in connection with the construction of the latter's plant at Cedar Rapids, Iowa, and from February to May, 1917, he was engaged as Field Engineer on the construction of reinforced concrete buildings for the Sinclair Oil Company, at Kansas City, Mo. Later, he went to Peterborough, Ont., Canada, as Engineer in Charge for the Quaker Oats Company on the construction of its immense plant at that place. He was also engaged at Saskatoon, Sask., Canada, on mill construction for the same Company.

When war was declared, Mr. Denham made repeated efforts to get into military service, but owing to a severe illness a short time before, he was unable to pass the physical examination. While working at Saskatoon, he received a Government appointment with the United States Bureau of Yards and Docks, at Charleston, S. C., and was on his way to that place when he was taken ill with pneumonia from which he died on October 23d, 1918.

While at Cornell Mr. Denham was a member of the Sigma Nu, Semaphore, and Glee Clubs, and he was also a member of the *Civil Engineer* Board.

Mr. Denham was elected a Junior of the American Society of Civil Engineers on April 17th, 1917.

PAPERS IN THIS NUMBER

"WATER SUPPLY FOR THE CAMPS, CANTONMENTS, AND OTHER PROJECTS BUILT BY THE CONSTRUCTION DIVISION OF THE UNITED STATES ARMY." DABNEY H. MAURY.

ADDRESS AT THE ANNUAL CONVENTION IN ST. PAUL AND MINNEAPOLIS, MINN., JUNE 17TH, 1919. FAYETTE S. CURTIS.

"CONTRACTS—A COMPARISON OF 'COST PLUS' WITH OTHER FORMS." ERNEST WILDER CLARKE. (To be presented September 3d, 1919.)

"PHYSIOGRAPHY OF WATER-SHEDS AND CHANNELS, AND ANALYSIS OF STREAM ACTION OF SOUTHERN CALIFORNIA RIVERS, WITH REFERENCE TO THE PROBLEMS OF FLOOD CONTROL." A. L. SONDEREGGER. (To be presented October 1st, 1919.)

"COMPREHENSIVE PLOTTING OF WATER TURBINE CHARACTERISTICS." KARL R. KENNISON.

"THE SILT PROBLEM OF THE ZUNI RESERVOIR." H. F. ROBINSON.

"THE ACCURACY OF WATER LEVEL RECORDERS AND INDICATORS OF THE FLOAT TYPE." J. C. STEVENS.

PAPERS AND DISCUSSIONS CURRENT IN PROCEEDINGS

"Cement Joints for Cast-Iron Water Mains." CLARK H. SHAW.....Mar., 1917
Discussion.....May, Aug., "

Final Report of the Special Committee on Steel Columns and Struts.....Dec., "
Discussion.....Feb., Mar., Apr., Aug., Oct., 1918

"Verification of the Bazin Weir Formula by Hydro-Chemical Gaugings."
FLOYD A NAGLER.....Jan., "
Discussion.....Mar., May, Aug., Nov., "

"Determination of the Duty of Water by Analytical Experiment." W. C. HAMMATT.....Feb., "
Discussion. (Author's closure.).....Apr., Oct., Dec., 1918, Mar., Aug., 1919

"The Economics of Steel Arch Bridges." J. A. L. WADDELL.....Mar., 1918
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"Improving Arch Action in Arch Dams." L. R. JORGENSEN.....May, "
Discussion. (Author's closure.).....Aug., Nov., 1918, Aug., 1919

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"The National Railroad Question of To-Day." FRANCIS LEE STUART.....Feb., 1919
Discussion.....Mar., Apr., May, "

"On a New Principle in the Theory of Structures." GEORGE F. SWAIN.....Mar., "
Discussion.....May, Aug., "

"The East Canyon Creek Dam." A. F. PARKER.....Mar., "
Discussion.....May, Aug., "

"Pressures in Penstocks Caused by the Gradual Closing of Turbine Gates."
NORMAN R. GIBSON.....Apr., "
Discussion.....May, Aug., "

"Sewage and Wastes Disposal for the United States Army." LEONARD S. DOTEN.....May, "
Discussion.....Aug., "

The Proposed New York and New Jersey Vehicular Tunnel: An Informal Discussion.....May, Aug., "

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William P. Morse

PROCEEDINGS

OF THE

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OF

CIVIL ENGINEERS

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WILLIAM P. MORSE

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CONTENTS

Society Affairs ..... Pages 795 to 866.
Papers and Discussions ..... Pages 611 to 712.

NEW YORK 1919

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ON THE REGULATION OF WATER RIGHTS: F. H. Newell, W. C. Hoad, John H. Lewis.

TO REPORT ON STRESSES IN RAILROAD TRACK: A. N. Talbot, A. S. Baldwin, G. H. Bremner, John Brunner, W. J. Burton, Charles S. Churchill, W. C. Cushing, Robert W. Hunt, George W. Kittredge, Paul M. LaBach, C. G. E. Larsson, G. J. Ray, Albert F. Reichmann, H. R. Safford, F. E. Turneaure, J. E. Willoughby.

The Reading Room of the Society is open from 9 A. M. to 10 P. M. every day, except Sundays, New Year's Day, Fourth of July, Labor Day, Thanksgiving Day, and Christmas Day; during July and August, it is closed at 6 P. M.

HEADQUARTERS OF THE SOCIETY—33 WEST THIRTY-NINTH STREET, NEW YORK.

TELEPHONE NUMBER.....4600 Vanderbilt.
CABLE ADDRESS.....“Ceas, New York.”

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AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PROCEEDINGS

This Society is not responsible for any statement made or opinion expressed in its publications.

SOCIETY AFFAIRS

CONTENTS

	PAGE
Minutes of Meetings:	
Of the Society, September 3d, 1919	795
Items of Interest	797
Announcements:	
Hours during which the Reading Room is open	822
Future Meetings	822
How to Make Remittances to the Society	822
Roll of Honor	822
Engineering Societies Employment Bureau	822
Searches in the Library	823
Papers and Discussions	823
Local Associations of Members of the American Society of Civil Engineers	823
Privileges of Engineering Societies Extended to Members	832
New Books	833
Membership (Additions, Deaths)	835
Recent Engineering Articles of Interest	836

MINUTES OF MEETINGS OF THE SOCIETY

September 3d, 1919.—The meeting was called to order at 8.30 P. M.; Vice-President Nelson P. Lewis in the chair; Charles Warren Hunt, Secretary; and present, also, 148 members and guests.

The minutes of the meetings of May 21st and June 4th, and of the Annual Convention, June 17th, 1919, were approved as printed in *Proceedings* for August, 1919.

A paper by Ernest Wilder Clarke, M. Am. Soc. C. E., entitled "Contracts—A Comparison of 'Cost Plus' with Other Forms" was presented by the author. The paper was discussed by J. A. L. Waddell, M. Am. Soc. C. E., who illustrated his remarks with lantern slides, and by Messrs. F. H. Frankland, J. Waldo Smith, Edward F. Hammel, Lazarus White, T. Kennard Thomson, A. P. Davis, Henry H. Quimby, J. P. H. Perry, H. B. Seaman, and the author.

The Secretary announced the following deaths:

Theodore Cooper, of New York City, elected Member, March 4th, 1874; died August 24th, 1919.

William Griffing Ford, of New York City, elected Member, October 5th, 1904; died June 23d, 1919.

Harry Hardy, of Lima, Peru, elected Associate Member, June 1st, 1892; Member June 1st, 1909; died April 4th, 1919.

Arthur Haviland, of New York City, elected Junior, January 4th, 1882; Member, January 4th, 1888; died June 18th, 1919.

John Gibson Hendrie, of Fort Worth, Tex., elected Junior, September 5th, 1911; Associate Member, April 2d, 1913; Member, May 12th, 1919; died June 18th, 1919.

George Stevens Leavenworth, of Ducktown, Tenn., elected Associate Member, June 3d, 1903; Member, February 5th, 1907; died August 9th, 1919.

Henry Kinder Owens, of Seattle, Wash., elected Member, March 6th, 1889; died May 15th, 1919.

George Sykes, of New York City, elected Junior, May 1st, 1906; Associate Member, December 4th, 1907; Member, May 12th, 1919; died August 21st, 1919.

Robert Dwiggins Monteith Henley, of Kansas City, Mo., elected Junior, September 3d, 1901; Associate Member, January 31st, 1911; died May 3d, 1918.

George Thomas Petheram, of North Yakima, Wash., elected Associate Member, February 28th, 1911; died October, 1918.

George Hippesley Stanley Stephens, of Pretoria, Transvaal, South Africa, elected Associate Member, December 5th, 1911; died December 13th, 1918.

Hugo S. Speidel, of Paterson, N. J., elected Junior, February 5th, 1890; died June 17th, 1919.

John Wesley White, of Baltimore, Md., elected Junior, April 14th, 1919; died June 2d, 1919.

Adjourned.

ITEMS OF INTEREST

The Committee on Publications will be glad to receive communications of general interest to the Society, and will consider them for publication in *Proceedings* in "Items of Interest". This is intended to cover letters or suggestions from our membership covering matters which are not of a technical character. Such communications, however, must not be controversial or commercial.

Classification and Compensation of Engineers

In the following letter from Arthur S. Tuttle, M. Am. Soc. C. E., Chairman of Engineering Council's Committee on Classification and Compensation of Engineers, some interesting facts are developed regarding a proposed classification of the Civil Service of Canada in comparison with the classification tentatively proposed by the Committee:

"Mr. Alfred D. Flinn, *Secretary*,

"Engineering Council.

"Dear Sir.—From time to time within the last few weeks, you have forwarded to me various letters addressed to you concerning the proposed 'Classification of the Civil Service of Canada' as recommended by Arthur Young and Company of Chicago, Toronto, and New York. The copy of this classification, which was also received, indicates that its preparation was authorized by the Canadian Parliament and that the work was done under the direction of the Civil Service Commission.

"Your correspondents offer objections to the classification, particularly on the ground that the compensations proposed for higher grades of service are inadequate. In view of the investigation now being made on behalf of Engineering Council as to the classification and compensation of engineers in Federal, State, Municipal, and Railroad service, this report is of more than usual interest, and especially so since Council's Committee is informed that Arthur Young and Company are performing a similar service for the Congressional Committee on Reclassification and Compensation of Government Employes, including engineers.

"Engineering Council's Committee on Classification and Compensation for the State and Municipal services has tentatively proposed that all positions in these services be limited to 13 in number, of which 7 are distinctly professional, while the remaining 6 are in a class directly leading to professional work, but not necessarily of a professional character. In the questionnaire recently issued by the Committee, the views of the responsible heads of the services affected are being sought, and in the responses which have been received up to the present writing, there has been practically unanimous agreement on the classification. The inquiry has not progressed far enough to warrant any expression as to the views concerning compensation other than to say that there is an unquestionably strong belief that if the engineering service is to be maintained on a proper plane, there must be a very substantial increase in pay.

"The Canadian report appears to cover every position in the civil service. It is arranged alphabetically and in the absence of grouping, a complete analysis of the engineering service involves a task of magnitude greater than I have found time for. I have attempted, however, to make such examination as time permitted and am impressed with a belief that the objections raised are well founded. No attempt seems to have been made to standardize titles. Consequently, there are in the engineering service at least 157 independent titles as compared with the 13 titles proposed by our Committee. It is recognized that qualification of a general title to show the nature of the service rendered is quite proper, but in the judgment of the writer there is no reason for treating similar positions as entirely unrelated and as warranting entirely independent specifications.

"The report states that the compensations proposed are intended for 'normal times' and that pending restoration of such times, the rates recommended should be 'supplemented by a bonus', but no information appears as to the magnitude of the bonus.

"From my study of the report it would appear that the groups and ranges of compensation, tabulated as far as practicable under the classification tentatively proposed by Engineering Council's Committee are about as follows:

TABULATION OF TITLES AND SALARIES FOR ENGINEERS IN CANADIAN CIVIL SERVICE REPORT UNDER CLASSIFICATION PROPOSED BY COMMITTEE OF ENGINEERING COUNCIL.

Tentative Classification of Positions in State and Municipal Service Proposed by Engineering Council's Committee on State and Municipal Service.	No. of Titles Provided in Proposed Canadian Classification.	Salary Range Proposed for Canadian Service.				Qualifications Proposed for Canadian Service.
		Usual.		Extreme.		
		Min.	Max.	Min.	Max.	
Consulting Engineer	1	$6 000	.....	.....	.....	Professional Engr., 12 yrs.' exper. (7 in charge).
Chief Engineer (major work)	5	6 000	.....	$4 800	.....	Professional Engr. 7-12 yrs.' exper. (3 to 7 in charge).
Chief Engineer (minor work)	7	3 900	$4 800	3 600	$6 000	Professional Engr. 7-12 yrs.' exper. (3 to 7 in charge).
Chief Engineer—Deputy	8	3 900	4 800	3 600	5 700	Professional Engr. 7-12 yrs.' exper. (3 to 7 in charge).
Engineer	37	3 300	4 020	3 000	4 500	Professional Engr. 5-10 yrs.' exper. (2 to 5 in charge).
Senior Assistant Engineer	40	2 640	3 000	2 400	3 480	Professional Engr. 3 yrs.' exper. (2 to 3 in charge).
Assistant Engineer	23	2 100	2 580	2 040	3 120	Professional Engr. 3 years' experience.
Junior Assistant	15	1 680	2 040	1 680	2 160	Professional Engr. 2 years' experience.
Senior Draftsman	..	Included in Professional Service.				
Draftsman	8	1 260	1 560	.....	.....	3 years' experience.
Junior Draftsman	4	900	1 200	.....	.....	2 years' experience.
Chief Instrumentman	..	Included in Professional Service.				
Instrumentman	5	1 260	1 560	.....	.....	3 years' experience.
Rodman	4	900	1 200	.....	.....	2 years' experience.

"In general, promotion through most of the grades is by increments of about $120, the minimum and maximum rates of each being, respectively, higher and lower than the rates fixed for the grades below and above, this resulting in a comparatively small salary range for each position and in this respect corresponding with what seems to have been the general practice heretofore. This treatment is one which it would seem desirable to modify to the end that the relative ability and experience of men performing similar work may be given adequate recognition.

"Exceptions are noted in the case of 'Topographical Engineer', where a salary range of from $2 160 to $3 120 is proposed, and in the case of promotion from 'Junior Electrical Engineer' at a maximum salary of $1 980 to 'Electrical Engineer' with a minimum salary of $2 640, each of the two latter grades having an extreme salary range of only $360. In the case of 'Chief Draftsman', 'Structural Engineer', and 'Chief Topographical Engineer', maximum salaries are proposed of $3 000, $3 240, and $3 840, with no provision for promotion to other engineering grades, although for each position the qualifications required are such as to indicate ability to progress to high positions in the service.

"The table also shows that only 6 engineering positions are open to compensation at a rate of more than $6 000 per annum.

"It would seem to the writer that this report is open to serious criticism on the grounds that it fails to group engineering service along orderly lines, that it provides too narrow limits for promotions within a grade, and that the compensation proposed for all grades, is inadequate for the service rendered. The latter criticism seems particularly pertinent in comparison with the rates now being demanded by organized labor. The practicability of properly meeting present-day conditions by the addition of a 'Special War Bonus' to the proposed rates in order to meet the present high cost of living is also to be questioned on the ground that, and as set forth in the circular letter issued by Council's Committee on Classification and Compensation of State and Municipal Engineers, the 'revolutionary change in the cost of living' is one which 'unless modified by further economic disturbance is likely to be permanent or to continue for a long time to come.'

"Very truly yours,

"Arthur S. Tuttle,

"*Chairman*, Committee on Classification and Compensation of Engineers, and of State and Municipal Section."

"New York, August 27th, 1919."

Committee on Development

A meeting of the Committee on Development of the Society will be held at the New Michigan Union, Ann Arbor, Mich., beginning on September 22d, 1919. It is expected that the Committee will conclude its work at this meeting and that its final report will be ready for presentation to the Board of Direction at its meeting on October 14th, 1919.

INFORMATION FROM THE NATIONAL SERVICE COMMITTEE OF ENGINEERING COUNCIL, WASHINGTON, D. C.*

The Engineer Corps under the Proposed Army Reorganization

The so-called "Army Reorganization Bill" now before Congress provides for a largely increased Corps of Engineers. The total engineer personnel under the Regular Army organization now provided by law is 12 933, while the bill before the Senate Committee on Military Affairs authorizes an enrollment of 28 338. The reorganization scheme provides that the Chief of Engineers shall have the rank of Major-General, whereas under the present law he is a Brigadier-General. Two brigadier-generals are provided and the number of colonels is increased from 23 to 43; lieutenant-colonels from 30 to 52; majors from 72 to 134; captains from 152 to 322; and first lieutenants from 148 to 431.

There is much speculation, inside as well as outside of the Service, as to the source from which this largely increased personnel of engineer officers will be secured. It seems apparent that a large number of the newly created commissions must be filled through the Reserve Corps or otherwise. Unless some fundamental change is made in the method of selecting engineer officers from among West Point graduates a large proportion of the engineer officers in service will lack those exclusive qualifications which have heretofore characterized the Corps by reason of the fact that engineer officers are, under the present law, selected from West Point graduates who have attained the highest rank in academic studies.

It is reported that since the signing of the armistice about 1 500 Regular Army officers have presented their resignations, and these include a number of engineer officers.

The National Budget

A National Budget System is favored by both the Republican and Democratic parties. A resolution has been adopted in both Houses, whereby select committees on the budget system have been appointed consisting of 10 members on the Senate Committee and 12 members on House Committee. To these committees will be referred all reports on bills, resolutions, and documents for the establishment of a National Budget System and proposed changes in dealing with appropriations, estimates, and expenditures. An outline of the budget plans for our own Government and the budget system used in foreign countries has been submitted together with an outline of the essentials of the budget system and anticipated results. The House Committee is to frame and present proposed legislation for a Budget System on or before March 1st, 1920.

* An additional item under this heading on "War Equipment for Trade and Technical Schools and Universities," will be found on p. 818.

Urges Appointment of an Engineer on Interstate Commerce Commission

The following self-explanatory letter was sent on August 14th, 1919, by J. Parke Channing, President of Engineering Council, to President Wilson:

"The President,

"The White House,

"Washington, D. C.

"Sir.—The transportation systems of our country are largely the creations of its professional Engineers. This statement can be made without disparagement to the statesmen, the financiers, the manufacturers, the lawyers, the educators, the mechanics, the laborers and many others, who, with the Engineers, have contributed to the development of transportation. Through all stages of preliminary exploration, final survey, construction, upkeep and operation, in financial management, and in adjustment of the relations of transportation to the public, the genius and knowledge of the Engineer are essential. Not only in technical physical matters, but also in determinations of policy, his contributions have supplemented and must ever supplement those of other men. These declarations hold good for all the carriers of commerce, by rail, by highway, by water, by pipe-line, by wire, or by air. Hence, it follows that the body established by Government to regulate the commerce, the carriers, and the ways of communication, embracing so many engineering features, should number among its nine members, men of engineering training and experience.

"Engineering Council, being aware of a vacancy on the Interstate Commerce Commission, begs leave to request the Chief Executive that, in filling this vacancy, he give earnest thought to the selection of a man who, to his other qualifications, adds the training and experience of an engineer familiar with transportation problems.

"Engineer members wisely chosen would bring to the investigations and deliberations of the Interstate Commerce Commission not only technical knowledge of great value, but also experience in executive duties, a judicial attitude gained through the direction of work under contracts, minds of analytical habit, familiarity with costs of construction and operation, experience in dealing with employes of many vocations, and integrity of thought cultivated by that inescapable obedience to the laws of Nature involved in the practice of this profession. The Engineer's training fits him for that mode of thinking which is indispensable to impartiality of judgment. One important function of the Commission is valuation of public utilities and another is the determination of relationships and responsibilities of the management of such utilities to the public. No other body of men has given so extensive and so scientific consideration to these matters as have members of the Engineering Profession.

"Council's purpose is not to further the interests of any individual or group, but solely to serve the Nation by strengthening one of its most important regulatory bodies. Upon the wisdom, intelligence, and courage of this Commission depend in large measure the commercial welfare of the country. It is believed that the Engineering Profession

can and should contribute to the country's well-being through the channel of membership in the Interstate Commerce Commission.

"Very respectfully,

"J. Parke Channing,

"Chairman."

The following letter on the same subject was sent to President Wilson under date of August 22d, 1919, by Francis Lee Stuart, M. Am. Soc. C. E., President of the Society of Terminal Engineers:

"The President,

"The White House,

"Washington, D. C.

"Sir.—The Committee on National Terminal Affairs of the Society of Terminal Engineers, being aware of a vacancy on the Interstate Commerce Commission, wishes to express to the President that it is the earnest desire of the Society of Terminal Engineers that in filling this or other positions on the Interstate Commerce Commission, he will give serious thought to the selection of men who, in addition to their other qualifications, have had the training and experience of an engineer familiar with transportation problems.

"The Society urges that the Engineering Profession which has contributed so largely to the creation and usefulness of all the transportation systems of this country, be represented in the membership of the Interstate Commerce Commission, believing that the training and attitude of mind of the engineer which have added so greatly to our national prosperity in the past will be of a similar usefulness to the nation in solving the problems which are to come before the Commission in the future.

"Very respectfully,

"Francis Lee Stuart,

"President, Society of Terminal Engineers."

Professions not Organized for Collective Bargaining

Writing for the New York *Tribune* commenting on the recent actors' strike, Heywood Broun says:

"The actor is in a disadvantageous business position as long as he must bargain individually. This is so generally recognized that the right of collective bargaining has been won in almost every other industry in the United States. Of course, objection may be made that professions may not be unionized as trades are. One may say that lawyers and ministers and college professors are not organized. That is true, but it does not seem to us to redound to the sagacity of the lawyers, the ministers and the college professors whose working conditions are on the average very much worse than those of printers and other skilled workingmen who have profited by organization. Mary McArthur, the English labor leader, recently pointed out in an address that the janitors of English schools drew higher pay than English school teachers. You may use this if you choose as an argument against the unionization of janitors, but we prefer to interpret it as an argument for the organization of teachers."

American Institute of Consulting Engineers Criticizes the Plumb Plan for Railroads

The Council of the American Institute of Consulting Engineers, under date of August 19th, 1919, addressed the following letter to the President of the United States:

"The Council of the American Institute of Consulting Engineers has given much consideration to the statement appearing in the public press on August 3d, 1919, signed by the executive heads of the Brotherhoods of Locomotive Engineers, Railway Trainmen, Locomotive Firemen and Enginemen, and the Order of Railway Conductors, respectively, and also by the President of the Railway Department of the American Federation of Labor.

"In view of the coercive and somewhat threatening tone of this statement and the fallacies in the economic arguments presented in it, the Council feels impelled by a sense of public duty to address you upon the subject, and file copies of this communication with the committees of Interstate Commerce of the two Houses of Congress.

"This Institute fairly represents the thought and sentiments of the Civil Engineering Profession which has played such an important part in the development of our railway systems—a profession which has been the pioneer in the location and construction of the railways and has taken a progressive and leading part in their scientific operation. In view of these facts we feel that our analysis of the statement of the Brotherhoods merits full consideration.

"The statement contains an argument for an increase of wages for the railway employes as a privileged class and a plea for a somewhat startling solution of the railroad problem, in that the latter contemplates Government ownership of the railroads with management in which the Brotherhoods practically dominate.

"(1) The statement is made that 'Labor faces a persistently serious situation due to the cost of living and the impossibility of wages keeping pace with the depreciation of money.' We suggest in answer that railroad labor does not face any more serious situation than that which confronts the average American citizen, especially the clerical and professional classes and the majority of investors, most of whom are indeed suffering more severely than railroad labor.

"(2) The statement is made that 'The railroad employes are in no mood to brook the return of the lines to their former control.' The natural inference formed from this coercive language is that the railroad employe has forgotten the vested property rights guaranteed by our Constitution, as well as the relation which the transportation system of the country bears to the interests of the general public.

"(3) The statement is made that '* * * inflated profits and the cost of goods mount faster than the wage level. A few grow wealthy and the multitude is impoverished.' We will show later from statistics that this is an erroneous statement. It is a matter of common knowledge that the many are less impoverished to-day than in any other period of our country's history. At no time has railroad labor enjoyed more of the luxuries of life than now.

"(4) The statement further adds: 'Not only have we suffered from inadequate wages, but the public has paid an extortionate tax for

transportation, a tax based on inflated values. * * *' Our search of available statistics reveals the following as an answer to the foregoing quotation:

Monthly Wages per Man of all Railway Labor

1916	$75.00
1917	90.00
1918	110.00
1919	125.00

"The average wage paid is now such that any further and material general increase cannot be justified unless it is to be assumed that railway labor is entitled to preferential treatment as compared to workers in other fields.

"It is stated that the average increase of wages paid the members of the four railroad Brotherhoods since 1916 has amounted to about $800 per annum, an increase of more than 60 per cent. In addition to previously granted increases in wages, the press states that requests for further increases, now in process of formulation but not officially presented, will, in the instance of the four Brotherhoods, amount to approximately, $300 000 000 per annum, and that the requests of other units of railroad workers who have already asked increases, and those who are preparing to do so, will amount to an additional $500 000 000 per annum, or a total of $800 000 000 per annum, a startling amount in the face of existing deficits of railroad operating income.

"During the periods named rates have averaged as follows:

Revenue per Passenger per Mile (cents)

1916	1917	1918
2.04	2.09	2.60

Revenue per Ton per Mile (mills)

7.07	7.15	9.0
Increase	1%	26%

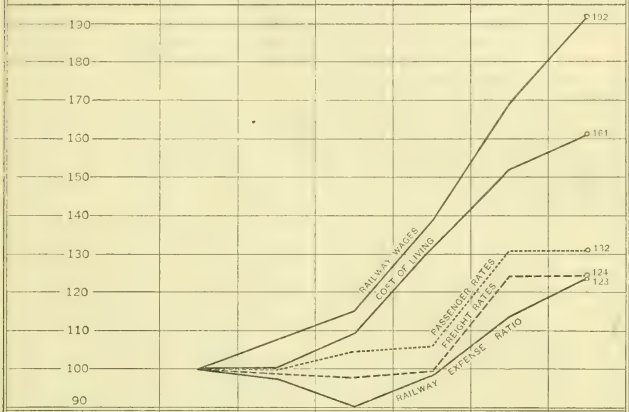
"These rates compared with those which obtain elsewhere, show that our people enjoy a much lower charge for freight than any other country in the world, and the statement that our rates for transportation are extortionate is not justified.

"The figures for 1918 given above also reflect the increase of passenger and freight rates made under Government operation to meet the increased payrolls, and the Director General of Railroads has recently stated that these increased rates are not sufficient to meet the existing railroad payrolls, and that a further increase of, approximately, 10% will be needed to offset the continued deficit of operation.

"We respectfully suggest that the above figures refute the statement of the Brotherhoods that they are suffering from inadequate wages. Our investigations show that railway wages have increased faster than the cost of living, which is contrary to the statements made by the Brotherhoods. The cost of living from 1914 to March, 1919, has increased 61%, whereas all railway wages have increased 92 per cent. We respectfully invite your attention to an accompanying dia-

UNITED STATES

CHANGES SINCE COMMENCEMENT OF EUROPEAN WAR IN RAILWAY RATES, RAILWAY LABOR, RAILWAY OPERATING RATIO, AND COST OF LIVING



		1914	1915	1916	1917	1918	1919
RY. OPER. RATIO	PER CENT OPER. EXPS. TO REVENUE	72.05	70.35	65.54	70.48	81.55	88.50
	PERIOD	Year ended June	Year ended June	Year ended Dec.	Year ended Dec.	Year ended Dec.	Month of April
RAILWAY LABOR	MONTHLY WAGES PER MAN	$65	$70	$75	$90	$110	$125
	PERIOD	Year ended June	Year ended June	Year ended Dec.	Month of Dec.	Year ended Dec.	Month of Jan.
RAILWAY RATES	REV. PER PASS. MILE, MILLS	19.76	19.79	20.42	20.91	26	26
	REV. PER TON MILE, MILLS	7.23	7.22	7.07	7.15	9	9
	PERIOD	Year ended June	Year ended June	Year ended Dec.	Year ended Dec.	Last 6 Months	Based on Increases of June 1918

gram which graphically shows the trend of railway wages, rates, and the cost of living.

"(5) Mention is made of 'The railroad profiteers * * * of Wall Street.' This is a generality that hardly needs refutation but is, however, deserving of criticism.

"In 1916 there were 30 706 miles of railroads in the hands of receivers, showing to what low ebb railroad credit had sunk, and the consequent financial condition of the alleged 'profiteers'. Statistics show that the great bulk of railroad securities is not held in 'Wall Street', as the term is commonly used. On the contrary, there are no securities of our Commonwealth more broadly held by our people than

our railroad securities, excepting war issues of Government bonds. There are, approximately, 700 000 stockholders of our railroads whose holdings average about $13 000 par per stockholder. From the records obtainable in respect to the distribution of railroad bonds, we find that the savings banks of our country own about $1 214 000 000 and the other banks about $472 000 000, making a total of $1 686 000 000. There are more than 11 000 000 depositors in the savings banks who are directly interested in these bonds, because their savings have been invested in them. In addition, our insurance companies hold bonds of about $1 520 000 000 and there are 34 000 000 insurance policy holders whose policies are in no small measure secured by these investments. As there are, according to the last published report of the Interstate Commerce Commission, about $10 000 000 000 worth of railroad bonds in the hands of the public, then $3 206 000 000, or 32% of them are held by insurance companies and banks in which the public has a direct and personal interest.

"Another point of public interest it seems to us is the fact that the four Brotherhoods have, according to the American Federation of Labor, a membership of 480 000, all of whom are not, however, employed upon the railroads. According to the last Interstate Commerce Commission report about 322 000 trainmen are engaged upon the steam railroads, as compared with a total number of all railroad employes of 1 800 000. It is, therefore, plainly seen that the powerful and well organized labor organizations which bespeak your consideration and that of Congress in favor of their solution of the railroad problem, and their threatening demands in respect to an immediate increase in wages, comprise only about 18% of all the railroad workers. For your consideration, and to show that the railroad workers are a comparatively small proportion of our total citizenry engaged in gainful pursuits, we submit the following from the latest census reports.

Occupation.	Male Employes of All Ages.
Agricultural pursuits	14 777 000
Mining and minerals	1 109 000
Manufacturing industries	11 484 000
Transportation, all classes	3 264 000
Trade	4 156 000
Public service	528 000
Professional service	1 912 000
Domestic and personal service	4 285 000
Clerical	1 938 000
Miscellaneous	750 000
Total	43 206 000*

"The percentage of all males in the transportation service (including trolley lines and other means of transportation) is 7.7% of the total; those engaged on steam railroads 4.2% of the total, and the members of the Brotherhoods only 0.8 of 1% of the total males engaged in gainful pursuits. It is the larger percentage for whom we bespeak your consideration.

*100 units ignored.

"(6) The statement is also made the 'The cost of capital would be reduced from the present 6 to 7% paid to Wall Street to 4% paid upon government securities'.

"This we affirm to be a serious misstatement. The last report of the Interstate Commerce Commission shows that the average annual interest rate on the total bonds outstanding against the railroads of this country was 4.9%, and upon the stock of our railroads but 3.91%, so that the statement in respect of the 7% as the cost of capital employed is entirely erroneous and misleading.

"The rate of interest on our Government bonds prior to our entry into the war was indeed less than the interest paid upon the railroad securities, due in part to privileges enjoyed by the holders of Government securities which are accepted as security for notes issued, deposits, reserves, etc. It is significant that the last loan, popularly called the Victory Loan, carried an interest rate of 4¾ per cent. Our net public debt on April 1st, 1917, was $1 207 827 886, a per capita debt of $11.59. On May 31st, 1919, the total gross debt was $25 921 151 273.75, or about twenty times greater, making a per capita debt of about $230. It is believed that the valuation of the railroads has progressed at least far enough to enable us to estimate that any fair valuation of the railroads of our country will approximate $18 000 000 000. Should the Government either assume this obligation or take over the railroads as suggested by the Brotherhoods, it follows that the Government credit will be extended to the amount of $18 000 000 000, and we feel assured that this amount of additional capital will not be available at less than a 5% interest rate. Furthermore, the increase of the public debt would depress the value of the war loan held by millions of our patriotic people.

"While the whole problem of our transportation system is under consideration, we suggest the scrutiny of all legislative restrictions which have been imposed upon the railroads and which have led to increased operating charges without compensating advantages to the public. A specific case in point is what is commonly termed the 'full-crew law'.

"We feel that the remedy for the present high cost of living rests not in increased wages, but in increased production, which largely rests in the hand of labor, in that increased efficiency and energy on their part will stimulate the output, resulting in increased output per unit. Recent inquiries and searches have revealed the fact that the output per unit has been decreasing in late years, coincidently with the increase in wages and shorter hours and, consequently, until this is corrected by greater individual industry, living costs cannot become normal.

"We commend and endorse your recent remarks that strikes and labor unrest retard production in general and increase the cost of all commodities, and we believe that your continued influence in this direction will result in better labor discipline without which efficiency is impossible.

"We hope we have advanced a sufficient answer to the demands of the Brotherhoods to show the fallacy of their arguments and the unstable economic foundation of their proposed solution of the railroad problem. We plead for a fair and comprehensive investigation

of the subject of increased wages. We feel that any increase of railroad wages should be considered with the greatest caution, being mindful of the conditions reflected in the above statistics. We remember that all classes of our people are confronted with the same conditions as the railroad Brotherhoods and that they are considering the subject with patience and a mutual understanding that should suggest to the Brotherhoods an equal consideration of the public good. Insofar as the plan proposed by the railroad Brotherhoods for the solution of the difficult railroad problem is concerned, we hope that you will use your great influence against it and urge some other plan which is based upon sound economic policy."

Treasury Department Urges Thrift

The people in many parts of the United States are virtually in league with the profiteers, according to William Mather Lewis, Director of the Savings Division of the Treasury Department, who has returned to Washington after visiting the various Federal Reserve Districts.

"A veritable orgy of extravagant buying is going on," he is reported as saying, "the reaction from the careful use of money during war time is widespread and disturbing. Retailers are securing goods from jobbers without arguing about prices, if they can only be assured of immediate delivery. They know their customers will scramble for the goods, regardless of cost. Thus, with an abnormal demand and a limited output, nothing else can be expected than high prices. It is a natural, though deplorable, consequence that profiteers abound.

"The people must return to the policy of careful buying and regular saving if they wish to help the situation. The Treasury Department, in order to combat this artificial situation, is intensifying and speeding up its thrift campaign. Statements on the principles of finance and the laws of investment and budgetry are being brought to workers in factories; to farmers; to business and professional men; and members of women's organizations by means of printed publicity and the spoken word. A nation-wide attack upon swindlers who are persuading people to dispose of their Liberty Bonds and War Savings Stamps is also being inaugurated.

"Throughout New England, savings and thrift organizations already are exerting their combined efforts to combat increased cost of the necessities of life. Savings directors and hundreds of officers of savings societies are taking the lead in disseminating information as to fair prices.

"In their communities they are aiding the determination and publication of fair prices and in curbing unjust profits. They are following the plan of campaign recently outlined by Governor W. P. G. Harding, of the Federal Reserve Board, to promote regular and efficient work to increase production and insure reasonable economies to devote that production to necessities rather than extravagances or luxuries.

"Steps are being taken to insure similar efforts throughout the other Federal Reserve Districts."

What the Army Engineers Did in France

The Engineer organization, in the form it had assumed when hostilities ended, consisted essentially of the following four main branches or divisions under the Chief Engineer, American Expeditionary Forces, whose headquarters were at Headquarters, Service of Supply, Tours, France: (1) Assistant to the Chief Engineer, A. E. F., at General Headquarters; (2) Division of Construction and Forestry; (3) Division of Military Engineering and Engineer Supplies; (4) Division of Light Railways and Roads.

Of all the technical services of the American Expeditionary Forces the Engineer Department was the largest. On November 11th, 1918, there were under the direct command or the technical supervision of the Chief Engineer, A. E. F., 174 000 Engineer troops, distributed as follows:

Character of Service:	Officers and Men:
With Armies	86 400
Miscellaneous	18 500
(Including troops in training, at schools, shops, etc.)	
Construction	43 000
(In the Service of Supply under the Division of Construction and Forestry.)	
Forestry	18 500
Supplies	7 600
Total Engineer Troops under C. E., A. E. F.	174 000

In addition there were engaged on road and construction work in the A. E. F., mainly under the supervision of the Division of Construction and Forestry, about 34 500 troops of other arms of the Service, 34 000 civilians and 15 000 prisoners.

In addition to the work of the Engineer Troops operating with the Armies, which maintained lines of communication, built bridges, fought as Infantry, conducted camouflage, searchlight, flash and sound ranging, water supply activities and many other special functions, the Engineers up to the end of 1918 (unless otherwise noted) accomplished the following results in the A. E. F.

Division of Construction and Forestry

Shelter for Troops.—A total of 15 039 barracks were erected which represented 285 miles of barracks placed end to end.

Hospitalization.—Space for 280 000 beds was provided, of which 145 913 represented new construction. New construction was equivalent

to 7 700 hospital barracks, 20 by 100 ft., which represented 146 miles in wards.

Ports.—Docks for ten vessels were constructed at Bassens. These were 4 100 ft. long and were equipped with switching facilities, warehouses, etc. For 3 months the average daily tonnage discharged at American Bassens was 3 700 tons. Docks at other ports for the use of sea-going ships were completed or partly completed when work was stopped by the armistice. Eighty-nine berths, totaling 7 miles, were either built or acquired from the French.

Lighterage.—A dock, 750 ft. long, at St. Loubes was completed; 84 lighters and 7 derricks barges were constructed.

Railroads.—Nine hundred and forty-seven miles of standard gauge railroad (most of it in yards) were completed, approximately the distance between Chicago and New York City; a 6-mile cut-off at Nevers, requiring a bridge across the Loire River, 2 190 ft. long, was built.

Storage Depot Warehouses.—Covered storage space constructed, was 21 972 000 sq. ft., or 500 acres, providing space for 90 days' reserve supplies for 2 120 000 men.

Remount Depots and Veterinary Hospitals.—Remount space was provided for 39 000 animals and Veterinary Hospital space for 23 000 animals.

Water Supply and Sewerage.—Much work was done to give pure water to troops. The supply of water for many large cities was chlorinated under Engineer control. Four million gallons per day were developed by artesian wells in the Bordeaux region. Pipe for sewerage in the Mesves Hospital project alone required 28 miles and for water supply the same quantity. Large municipal water supply developments were made at Brest and St. Nazaire.

Refrigeration.—A refrigeration plant was built at Gievres with daily capacity of 5 200 tons of meat and 375 tons of ice. Three other plants were built.

Bakeries.—Mechanical bakeries to produce 500 000 lb. of bread every 24 hours were constructed at Is-sur-Tille. The construction of bakeries of 80 000 lb. capacity in three other cities was stopped by the armistice.

Power Plants.—Electric power was obtained from existing sources and by new construction in the form of central stations and transmission lines.

Oil and Gas Storage.—By the construction of tanks at the sea coast, storage was provided for 150 000 bbl. Sixty-nine 300-bbl. tanks and one-hundred and fifty 150-bbl. tanks were manufactured for distributing stations. Seventeen complete storage stations, including pumps, were put in operation.

Forestry.—Eighty-one mills were in operation in October. The total production to December 1st was: 189 564 000 ft. b. m. of

lumber; 2 728 000 standard gauge ties; 923 560 narrow gauge ties; 1 739 000 poles and pit props; 892 200 steres of fuel wood; 38 200 pieces of piling. The fuel wood, if corded, would extend 375 miles.

Roads.—The maintenance and repair of 300 miles of road and 90 miles of new roads in the S. O. S., exclusive of the Advance Section, was accomplished.

Division of Military Engineering and Engineer Supplies

Engineer Supplies.—From March to December 31st, 1918, the total tonnage of Engineer supplies received from the United States was 1 496 489; total tonnage received from all sources was 3 255 121. On November 11th, 1918, the total covered space occupied by Engineer supplies was 764 000 sq. ft. Total open space occupied was 14 352 000 sq. ft. Nine storage depots were maintained. Repair shops were operated to care for Engineer supplies. Shops made 100 firing platforms for 75-mm. guns, 30 ponton wagons, one hundred 500-gal. water tanks, and completed more than 2 000 orders before the armistice.

Cement Mills.—Seven cement mills were operated by Engineer troops, producing 55 000 tons, or 315 000 bbl., of cement during five months' operation. Concrete pipe amounting to more than 100 miles was made for A. E. F. use.

Division of Light Railways and Roads

Light Railways.—Total tonnage handled up to February 1st, 1919, was 860 652, of which 166 202 tons was ammunition. In one week 10 600 tons of ammunition were handled. In six nights, 23 135 soldiers were carried. The daily net tonnage handled in October, 1918, was 8 100. In one week 10 700 tons of rations were handled. At the time of the armistice 2 240 km. of light railway were in operation, of which 1 740 km. had been taken from the Germans, the remainder having been newly constructed or rebuilt. On November 11th, 165 locomotives and 1 695 cars were available for use. In five hours, 135 men laid 14 200 ft. of light railway track. Ten shop buildings, 70 000 sq. ft. total area, were constructed at Abainville; 125 acres were occupied by shop project; 2 300 cars were erected; and 140 locomotives repaired.

An appreciation of the services of the Engineers is contained in the following letters from the Commander-in-Chief:

"20 February, 1919.

"Major General William C. Langfitt,

"*Chief Engineer*, A. E. F.

"My dear General Langfitt.—As the activities of our army in France draw to a close, I desire to express to you, and through you to the officers, enlisted men and civilian personnel of the Engineer Depart-

ment, my appreciation of their loyal and energetic work, which contributed so greatly to our success.

"The various units attached to combat troops distinguished themselves at all times in the assistance which they rendered. The Division of Construction and Forestry, with limited resources at its disposal and under conditions of extreme severity, more than met the many demands made upon it. The Department of Light Railways and Roads furnished the indispensable link between the railheads and the front lines for the transportation of troops and supplies, and for the evacuation of sick and wounded. Its record in the construction and operation of light railways and roads has seldom been equalled.

"The many other services of the Engineer Department, connected with the acquisition and distribution of engineer supplies, particularly those needed for combat operations, were so conducted that our forces never lacked for any essential.

"The Engineer Department has made a proud record for itself, and it gives me pleasure to express to you my sincere thanks and admiration, and that of your comrades of the American Expeditionary Forces, for its splendid achievements.

"Sincerely yours,

"JOHN J. PERSHING."

"28 March, 1919.

"BRIGADIER GENERAL EDGAR JADWIN,

"*Director,* Construction and Forestry,

"Through Chief Engineer, American E. F.

"MY DEAR GENERAL.—Now that hostilities have ceased, it gives me great pleasure to thank you, and through you the officers and soldiers of your organization, for the splendid work you have accomplished.

"The Division of Construction and Forestry required the services and unselfish efforts of experts in many lines of skilled endeavor. It is a source of deep pride and satisfaction that numbers of this type of men responded readily, and through their invaluable assistance you attained the highest goal of achievement.

"The supply and shelter of troops was one of the most responsible tasks that befell any organization. Although operating in a foreign country, under conditions and circumstances vastly dissimilar to those accustomed to, you met successfully each and every demand.

"You, and the officers and men of your organization, labored in almost every department in France, often in isolated detachments, working under arduous conditions of service and making countless sacrifices. Yet they withstood all hardships and difficulties, surmounted all obstacles and kept tenaciously at their important tasks. Such tireless energy, actuated as it was by a high sense of duty, deserves the commendation of all.

"The vast projects wisely planned and boldly executed by you and your efficient personnel, the thoroughness and celerity with which you labored, the splendid co-operation maintained throughout, especially among the highly trained men of affairs who gave their best to the common cause, the keen foresight displayed in preparing for emergencies and the many sacrifices made are worthy of the highest American traditions.

"In the name of the American Expeditionary Forces, I thank them one and all and send them the appreciation of their comrades and their Commander-in-Chief.

"Sincerely yours,
"JOHN J. PERSHING."

Resolutions on the Death of Andrew Carnegie

At a joint meeting of representatives of the Founder Societies and the Engineers' Club, held on August 12th, 1919, in the Engineering Societies Building, the following resolutions on the death of Andrew Carnegie were adopted:

"Andrew Carnegie's death, August 11th, 1919, at Lenox, Mass., brought to its close a career which greatly advanced all the engineering arts and sciences. By the introduction into the United States of the Bessemer process for the production of steel and by the establishment and development of steel plants, which became the greatest in the world, he made available for engineers the most useful modern material for engineering construction. In the successful conduct of many industrial enterprises, he amassed great wealth, the possession of which he came to regard with deep seriousness as a public trusteeship. He devoted himself to the distribution of large portions of his fortune to projects for the benefit of Mankind. He distributed his wealth not only in many directions, but also with the exercise of great wisdom based on careful investigation. His munificence provided large funds for the building of a home for the great national engineering societies and many associate societies. He was an honorary member of the American Institute of Mining and Metallurgical Engineers and American Society of Mechanical Engineers. He was personally known and loved by many engineers. In view of these facts, be it

"*Resolved*, That the American Societies of Civil, Mining, Metallurgical, Mechanical and Electrical Engineers, the United Engineering Society and the Engineers' Club, herein express to the family of Mr. Carnegie and record their sincere appreciation of the great contributions of Andrew Carnegie to the advancement of engineering, and of his friendly assistance in making possible beautiful homes for the Engineering Societies and the Engineers' Club, thus fostering the spirit of unity in the Profession."

Indian Engineers Organizing an Institution

The movement of the Engineering Profession to found an institution for itself in India passed another stage on July 16th, 1919, when a revised code for the proposed body was presented for the consideration of a meeting held in Gorton Castle, Simla. There were 26 engineers present, many of whom are in government service. T. R. J. Ward, M. Am. Soc. C. E., acted as Chairman of the meeting. The principal matter discussed was the relation of Local Associations to the Parent Body.

Registration of Professional Engineers in Oregon

The State Board of Engineering Examiners is now fully organized and prepared to receive applications for the registration of the professional engineers in Oregon, and others who expect to practice engineering in Oregon. The personnel of the Board is as follows: F. S. Baillie, Baker, Mining Engineer; R. R. Bartlett, Astoria, Civil Engineer; G. A. Covell, Corvallis, Mechanical Engineer; W. B. Dennis, Carlton, Mining Engineer; F. Hesse, Portland, Mechanical Engineer; E. G. Hopson, M. Am. Soc. C. E., Portland, Hydraulic Engineer; O. Laurgaard, M. Am. Soc. C. E., Portland, Civil Engineer; J. H. Lewis, Assoc. M. Am. Soc. C. E., Vale, Hydraulic Engineer; and F. D. Weber, Portland, Electrical Engineer.

The Board has held several meetings and has worked out and adopted complete by-laws, rules, and regulations for the government of its members and methods for holding examinations.

The following officers have been elected to serve for the next biennium ending July 1st, 1921: O. Laurgaard, M. Am. Soc. C. E., City Engineer of Portland, President; F. D. Weber, Electrical Engineer for the Oregon Insurance and Rating Bureau, Vice-President; and A. B. Carter, Civil and Mining Engineer, Secretary.

Headquarters have been established at 520 Corbett Building, Portland, Ore., where the necessary application blanks for registration without examination, and copies of the law, and all other information may be had.

The business of the Board will be transacted to a large extent by committees which have been appointed as follows:

Executive Committee.—O. Laurgaard, E. G. Hopson, and G. A. Covell.

Finance Committee.—F. D. Weber, Chairman, W. B. Dennis, and R. R. Bartlett.

By-laws and Rules Committee.—F. Hesse, Chairman, F. S. Bailey, and John H. Lewis.

Under the provisions of the law, it will be necessary for all Civil, Mechanical, Electrical, Mining, Chemical, and all branches of professional engineering, to register.

Applications may also be made for examination by those engineers who have not the required six years of actual practical experience.

The Board has announced that it is important that all engineers who expect to register without examination, file their application blanks as soon as possible, in order that the Board may have sufficient time to pass intelligently on their qualifications.

The professional engineers who expect to practice after January 1st, 1920, according to the law must be registered, so it is important

that the applications of not only those who expect to be registered without examination, but also those who expect to take the examination should be filed before January 1st, 1920.

State Laws Licensing Engineers

According to the best information obtainable by the License Committee of Engineering Council, laws providing for the licensing of engineers are on the statute books of the following eleven States: Wyoming, 1907; Louisiana, 1908 (amended 1914); California, 1909; South Dakota, 1913; Illinois, 1915; Idaho, 1915; Florida, 1917; Oregon, 1919; Colorado, 1919; Michigan, 1919; Iowa, 1919.

The License Committee is working on a draft of a typical bill which, it is intended, can be used if necessity should arise in States proposing new legislation on this subject, or in those proposing revisions, so that laws enacted for licensing engineers may be uniform, or nearly so, throughout the country.

Engineering Council, however, has as yet taken no stand on the desirability of licensing or registering engineers. It desires to learn the opinions of engineers in various branches of the Profession in all parts of the country and to secure as soon as possible all information that would be helpful to the Committee.

Seek $8 000 000 Endowment Fund for M. I. T.

A nation-wide drive for an endowment fund of $8 000 000 for the Massachusetts Institute of Technology, Cambridge, Mass., has been announced by Mr. H. Coleman du Pont, of New York City. The drive is to continue until January 1st, 1920. Four million dollars has already been promised by "Mr. Smith," the unrevealed benefactor of the Institute, on the condition that at least $4 000 000 in addition be obtained from other sources. The appeal will be made largely to leaders in the industrial field who realize the necessity for the application of technical education to industrial pursuits, but it is hoped that patriotic men and women who desire to see the United States excel in the technical field will contribute liberally.

The Endowment Fund Committee is headed by Mr. du Pont. The other members are Theodore N. Vail, Charles A. Stone, Otto H. Kahn, and Charles Hayden of New York; Everett Morse of Boston, Edmund Hayes, M. Am. Soc. C. E., of Buffalo, and Richard C. MacLaurin, President of the Institute. Contributions will be received by Mr. Stone or Mr. du Pont at the offices of the Committee, 120 Broadway, New York City.

The unnamed donor has already given $7 000 000 to the Institute and the latest gift brings the amount of his benefactions up to $11 000 000.

Why the United States Entered the Great War

Maj.-Gen. Sir Frederick Maurice, probably the best known British military critic, in an article in the *New York Times,* gives the following reasons for the entry of the United States into the war against Germany:

"It is a truism to say that the forces which shape the foreign policy of the United States are idealism and intense national feeling.

"This must be so, for the country is so vast, so much of it is removed from direct contact with the outer world and has at hand so much to occupy its energies that only the broadest and simplest ideas, touching foreign relations, can make any general appeal.

"Now that the national feeling of America has been aroused as a consequence of the war, its strength must astonish any visitor and has amazed not a few Americans. We are rather too apt to regard community of language as implying community of blood and to call the Americans cousins.

"A British visitor to New York, Boston, and Philadelphia may find little to shake any preconceived notions that he has formed in these matters, but let him travel far and wide through the States and he will soon learn that to the majority of Americans the Britisher is a foreigner, with whom he is more disposed to be friendly to-day than he has been for generations, but still a foreigner.

"During the early years of the war the British were bitterly disappointed that there were so few signs that 'blood was thicker than water' and that our cousins did not at once take up arms and come to our help. The plain fact is that to-day English blood has become so mingled with that of the other races which have poured into the United States that the call of kinship was not by itself strong enough to move the American people as a whole. Something more potent was needed and by the mercy of Providence the Germans supplied it.

"Bernstorff has always been reputed to be astute, and how he can have allowed the German Government to be so crazily stupid in their dealings with America passes comprehension. That he should have lived as long as he did in the United States without knowing that a message, conveying permission to America to send one ship a week, colored in a particular way, at a fixed time, by a fixed route, to a British port, would set the whole country in a blaze from end to end, is one more proof of the strange mentality of the German Junker. America did not come into the war for the British *beaux yeux,* or even out of sympathy with France, though this made a much stronger appeal to her, but because her national pride was deeply touched.

"Germany's audacity and the President's call to the United States to make the world safe for democracy appealed to just those forces which alone could unite the whole people and gave them a cause for which they were ready to make any sacrifices.

"Americans who came over immediately after the United States declared war told the British that their country was in the struggle 'with both feet', and she was. There were very few well-informed Englishmen, who in 1916 believed that it would be possible for America to carry through at once and without difficulty a measure of universal

service, such as the British reached after many delays and troubles, or to apply compulsion to labor in a way which the British never dared to attempt."

National Board for Jurisdictional Awards in the Building Industry

A meeting for the purposes of organizing the National Board for Jurisdictional Awards in the Building Industry was issued for August 11th, 1919, by William J. Spencer as Temporary Secretary. The meeting was held in the American Federation of Labor Building, Washington, D. C.

The Board elected as its Permanent Chairman, E. J. Russell of St. Louis, Mo., representative of the American Institute of Architects, and as its Permanent Vice-Chairman, William L. Hutcheson, representative of the American Federation of Labor. No other officers were elected, but Mr. William J. Spencer was designated to act as Secretary of the Board.

Present at the meeting were: E. J. Russell, representing the American Institute of Architects; Mr. Harding, representing the Associated General Contractors of America; Messrs. William L. Hutcheson and William Dobson, representing the Building Trades Department, A. F. of L., and Rudolph P. Miller, M. Am. Soc. C. E., as representative of Engineering Council.

The Secretary read a lengthy list of matters in dispute, which will come up for consideration by the Board. In none of these cases, however, had the issues been presented in the prescribed manner or in such a way that any action could be taken on them at the time. The Secretary was instructed to notify the interested parties to submit their cases in the prescribed manner for consideration by the Board at its next meeting, which will occur early in November, unless the Chairman issues a call previous to that time. Other matters of minor importance were considered.

New Engineering School

A new school of engineering is to be established in Pennsylvania under the joint direction of the Carnegie Institute of Technology, the United States Bureau of Mines and the coal operators of the Pittsburgh District. The announcement has been made by the Carnegie Institute of Technology of Pittsburgh, and the new school is part of the movement it is making into the field of industrial research. The Advisory Committee to administer the affairs of the school is made up as follows: Dr. Arthur A. Hamerschlag, President of the Carnegie Institute of Technology; W. A. Luce, General Manager of the Ellsworth Collieries Company; Philip Murray, President of the Mine Workers of America; John I. Pratt, State Mine Inspector of Pennsylvania; J. M. Armstrong of the Pittsburgh Coal Company; W. L.

Affelder of the Hecla Coal and Coke Company; C. E. Cowan of the Jamison Coal and Coke Company; Dr. D. A. Lyon of the Pittsburgh Station of the United States Bureau of Mines; and Captain Edward Steidle, Associate Professor of the School of Mining at the Institute of Technology.

War Equipment for Trade and Technical Schools and Universities

A bill which was proposed in the last session of the 65th Congress "providing further educational facilities by authorizing the Secretary of War to sell at reduced rates certain machine tools not in use for Government purposes to trade, technical schools, universities and other recognized educational institutions," was re-introduced early in the present session of Congress and has been reported favorably by the Military Affairs Committee. An amendment has been affixed to this bill whereby the educational institutions are to pay 20% of the purchase price of the tools even when depreciation is taken into consideration, instead of 10% as proposed in the original bill. In the meantime, the Director of Sales announces that the Machine Tool Section is operating with representatives of the several Bureaus of the War Department which have surplus machine tools and is fixing prices at which all standard tools held by the Department will be offered for sale. Because of the large and greatly diversified stock of these tools now held by the War Department, it is contemplated that the requirements of the technical schools can be amply and quickly taken care of following the passage of the proposed bill.

BRIEF NOTES

The Eighth Annual Safety Congress will meet at Cleveland, Ohio, October 1st-4th, 1919. The sessions will be held at the Hotel Statler.

Professor Charles J. Tilden, M. Am. Soc. C. E., head of the Department of Civil Engineering, Johns Hopkins University, has been called to the Sheffield Scientific School of Yale University as head of the Department of Engineering Mechanics, and will begin his duties in that position this month. Professor Tilden has served nearly six years as head of the Department of Civil Engineering at Johns Hopkins.

MacArthur Brothers Company, of New York City, has been awarded a contract for 2 000 small wooden houses ready for erection, which will be shipped to France. The contract does not cover erection in the field, but includes all the necessary pieces of lumber, roofing, windows, and nails.

The Society has received from Col. Mark L. Ireland, U. S. A., of the Motor Transport Corps, A. E. F., the following publications: "Regulations for Standard Motor Vehicle Operation", "Manual of the

Motor Transport Corps", and "Repair Park Operation—Instructions for the Use of Officers and Men of the Motor Transport Corps". The last named is from the press of the Central Printing Plant, American Expeditionary Forces, and is a creditable example of printing and binding.

Road building to the extent of an additional $400 000 000 was recommended by a resolution signed by twenty Governors of States at a recent conference in Salt Lake City, Utah.

Trans-Pacific wireless communication in addition to the recently proposed cable system is said to be under consideration by American and Japanese business interests.

Dantzig, Pfeiffer and Ritt, is the title of a firm of consulting mathematicians with headquarters at 500 West 116th Street, New York City. The firm, which is said to be the first of its kind, will undertake to handle problems in industry for the solution of which the knowledge possessed by mathematical specialists may be necessary.

Every man owes some of his time to the upbuilding of the profession to which he belongs.—*Theodore Roosevelt.*

Brig.-Gen. C. H. McKinstry, U. S. A., M. Am. Soc. C. E., has been ordered to Governor's Island, N. Y., as Eastern Department Engineer.

The work of repairing more than 6 000 km. of roads in the Somme district, where four armies fought during the entire duration of the war, has been started. The repairs, it is estimated, will cost 100 000 000 francs. A large part of the American army tractors and road building machinery will be used on the Somme roads. The first to be reconstructed will serve as models for the other roads in the other devastated departments. Many of the 173 bridges destroyed by the enemy are also being replaced. Five minor bridges across the Somme already have been rebuilt. The Somme River itself represents an immense reconstruction task, as tons of débris were thrown into it during the years of fighting. This has been choking the free movement of the river and preventing navigation. It will have to be removed, and the process will be slow and difficult.

Col. Frederick Mears, U. S. A., M. Am. Soc. C. E., formerly General Manager of the Transportation Service, A. E. F., has been appointed Chairman and Chief Engineer of the Alaska Engineering Commission in charge of building the Government railroad.

William B. Poland, M. Am. Soc. C. E., Director for Europe, Commission for Relief in Belgium, has been named as a member of the American Mission, headed by Maj.-Gen. James G. Harbord, which is to investigate conditions in Armenia and Transcaucasia.

Philip N. Moore, Past-President, American Institute of Mining and Metallurgical Engineers, and member of Engineering Council, in connection with his journey as a member of the War Minerals Relief Board, recently met groups of engineers in the interests of Engineering Council and propaganda for a National Department of Public Works, at Los Angeles, San Francisco, Portland, Ore., Seattle, Spokane, Butte, Denver, and Salt Lake City.

It is reported from Brussels that a commission consisting of Belgian and British architects, has been formed to study and report on the reconstruction of Ypres. The town is to be rebuilt on the same site, and the inhabitants will be required to preserve in rebuilding their homes the same style which characterized Ypres before the war.

Secretary Redfield, in a letter to the Senate Committee on Commerce, stated that it will cost $30 000 000 to construct the proposed Pacific cable.

It is reported that the Italian State Railways are being offered to American financiers as security for a loan to Italy. The management of the railways would be assumed by Americans.

The Shipping Board announced on August 14th, 1919, that a tabulation made on August 13th, shows a total of 1 227 vessels delivered up to the week ending August 9th. During that week 30 vessels, representing 97 550 gross tons, were turned over to the Board by the Emergency Fleet Corporation. The gross tonnage delivered to date is 4 542 278.

Secretary Redfield has requested Congress for $410 000 for the work of the Bureau of Standards in assuring full weight and measures, and for that of the Bureau of Fisheries in introducing new fish foods, in the campaign against inflated prices.

It is reported that Roger Babson, Bay State Railways Director, told the Federal Electric Railways Commission that automobiles were responsible for much of the street car traffic loss. Massachusetts street cars total 5 000 against 186 000 automobiles. Mr. Babson suggested that the paving charges against the traction companies be removed.

It is announced from Tokyo that prominent Japanese business men have decided to float a $25 000 000 company for the purpose of laying a cable line between the United States and Japan.

M. Demorlaine, Inspector of Forests and Rivers and Professor in the Agronomical Institute, France, estimates the damage caused to the forests of France, directly or indirectly by war, at 600 000 hectares of forest, worth 1 600 000 000 francs.

Evidence that returned soldiers, particularly those who saw service overseas, are going back into civil pursuits better fitted for work,

is furnished by one of the largest employers in the United States. The Department of Labor states that of more than 600 returned soldiers who have been employed by this corporation, 43% have proved more efficient than they were before their military experience.

The War Department announces that the Chief Signal Officer has been authorized to send six officers to the Massachusetts Institute of Technology, and six officers to Sheffield Scientific School of Yale University, for the purpose of taking special technical courses. The Chief of the Coast Artillery has been authorized to send eight officers to technical schools for the purpose of taking advanced courses in technical subjects of use to the Coast Artillery.

L. Michalski, City Architect of Warsaw, who has been sent to the United States by the Polish Government to study transportation, construction, subway building, and modern housing, states that it is planned to modernize Poland along American lines.

The War Department was advised on August 28th, 1919, by the Special Liquidation Commission that the sale to France for $400 000 000, of all American Expeditionary Force property in that country, except that withheld for return to the United States and for the use of troops remaining, is provided for in a contract signed with the French Government.

The War Department announces that the plan of the Commanding General, S. O. S., in France, is to use the port of Brest as the one port of embarkation in Europe until all activities in France have been closed and the personnel evacuated. When this is accomplished, the port of Brest will be closed, and embarkation activities will be transferred to Antwerp, Belgium, as the one port of embarkation.

The Railroad Administration announces that two of the forty 2 000-ton barges, built for use on the Lower Mississippi River have been delivered. Other deliveries will follow shortly.

The Chicago *Tribune* states that seventy-one American companies, which before the war operated no steam vessels, now own and operate 358 steamships of 1 729 000 tonnage.

ANNOUNCEMENTS

The Reading Room of the Society is open from 9 A. M. to 10 P. M., every day, except Sundays, New Year's Day, Fourth of July, Labor Day, Thanksgiving Day, and Christmas Day; during July and August, it is closed at 6 P. M.

FUTURE MEETINGS

October 1st, 1919.—8.30 P. M.—A regular business meeting will be held, and a paper entitled "Physiography of Water-Sheds and Channels, and Analysis of Stream Action of Southern California Rivers, with Reference to the Problems of Flood Control", by A. L. Sonderegger, M. Am. Soc. C. E., will be presented for discussion.

This paper was printed in *Proceedings* for August, 1919.

October 15th, 1919.—8.30 P. M.—The usual meeting will be held on this date, and announcement of the speaker and subject will be made later.

HOW TO MAKE REMITTANCES TO THE SOCIETY

The attention of members is called to the rule (see Year Book, 1919, page 20), that all remittances should be made payable to the order of the American Society of Civil Engineers. Checks, drafts, money orders, etc., should never be drawn to the order of an individual in payment of a bill from the Society. Observance of the rule will expedite clerical work and prevent avoidable delay in the closure of accounts.

ROLL OF HONOR

Now that the war is over, the monthly publication in *Proceedings* of the Roll of Honor has been discontinued. It is planned to publish later for permanent record a list of all the members of the American Society of Civil Engineers whose names have appeared on this list.

ENGINEERING SOCIETIES EMPLOYMENT BUREAU

Engineering Societies Employment Bureau, established December 1st, 1918, as an activity of Engineering Council, is managed by a board made up of the Secretaries of the four Founder Societies, funds for its maintenance being provided by these Societies. The Bureau already is co-operating with engineering organizations in all parts of the country and with the Professional Section of the United States Employment Bureau. It is desirous of increasing such co-operation by working with local engineering associations and clubs. The work of the Bureau since its inception has been largely in the line of securing employment for men retiring from government war service. Members of the American Society of Civil Engineers who desire to register with this Bureau

should apply for further information, registration forms, etc., to Walter V. Brown, Manager, Engineering Societies Employment Bureau, 16th Floor, Engineering Societies Building, 29 West 39th Street, New York City.

SEARCHES IN THE LIBRARY

As the Library of the American Society of Civil Engineers has been merged in the Engineering Societies Library, requests for searches, copies, translations, etc., should be addressed to the Director, Engineering Societies Library, 29 West 39th Street, New York City, who will gladly give information concerning the charges for the various kinds of service. A more comprehensive statement in regard to this matter will be found on page 21 of the Year Book for 1919.

PAPERS AND DISCUSSIONS

Members and others who take part in the oral discussions of the papers presented are urged to revise their remarks promptly. Written communications from those who cannot attend the meetings should be sent in at the earliest possible date after the issue of a paper in *Proceedings*.

All papers accepted by the Publication Committee are classified by the Committee with respect to their availability for discussion at meetings.

Papers which, from their general nature, appear to be of a character suitable for oral discussion will be published as heretofore in *Proceedings*, and set down for presentation to a future meeting of the Society, and, on these, oral discussion, as well as written communications, will be solicited.

All papers which do not come under this heading, that is to say, those which from their mathematical or technical nature, in the opinion of the Committee, are not adapted to oral discussion, will not be scheduled for presentation to any meeting. Such papers will be published in *Proceedings* in the same manner as those which are to be presented at meetings, but written discussions only will be requested for subsequent publication in *Proceedings* and with the paper in the volumes of *Transactions*.

The Board of Direction has adopted rules for the preparation and presentation of papers, which will be found on page 35 of the Year Book for 1919.

LOCAL ASSOCIATIONS OF MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

San Francisco Association, Organized 1905.

E. J. Schneider, President; Nathan A. Bowers, Secretary-Treasurer, 502 Rialto Building, San Francisco, Cal.

The San Francisco Association of Members of the American Society of Civil Engineers holds regular bi-monthly meetings, with banquet, and weekly informal luncheons. The former are held at 6 P. M., at the Engineers' Club, 57 Post Street, on the third Tuesday of February, April, June, August, October, and December, the last being the Annual Meeting of the Association.

Informal luncheons are held at noon, every Wednesday, at the Engineers' Club, where special tables are reserved for members and guests of the Association.

The by-laws of the Association provide for the extension of hospitality to any member of the Society who may be temporarily in San Francisco, and any such member will be gladly welcomed as a guest.

(Abstract of Minutes of Meeting)

June 3d, 1919.—The meeting was called to order at the Engineers' Club; President E. J. Schneider in the chair; N. A. Bowers, Secretary; and present, also, 45 members and guests.

The Secretary read extracts from a letter from a Chicago engineer relative to the engineering societies of that city; reports from Engineering Council detailing some of its recent activities; and a letter from Professor Otto B. Goldman, of the Oregon Agricultural College, relative to the unionization of professional engineers.

The Secretary announced the deaths of Messrs. H. F. A. Schussler and Carl Uhlig, members of the Association, and, in accordance with a suggestion from the Secretary of the Society, President Schneider appointed committees to prepare memoirs, as follows: Messrs. Grunsky, Herrmann, and Elliott, for Mr. Schussler, and Messrs. White, Newman, and Holmes for Mr. Uhlig.

On motion, duly seconded, these committees were instructed also to prepare appropriate resolutions of sympathy to be sent to the families of the deceased.

Mr. H. D. Dewell, reporting for the Membership Committee, stated that 56 members and guests had gone on the inspection trip to the Mare Island Navy Yard, on May 24th, 1919. The party was met by Commander Reed and a corps of assistants who conducted them through part of the Yard before lunch. At luncheon, the party was officially welcomed by Captain Ellicott, representing the Commandant, and President Schneider responded for the members of the Association. After lunch, the party was divided into groups, assigned to automobiles, and taken through the Yard, with specially detailed officials to explain the points of interest, which included work on the new battleship, *California,* the large foundries, boiler shops, etc., including the electric furnace, central power plant, and the new causeway connecting Mare Island with the City of Vallejo. Great interest was also taken in the work on the destroyers being constructed at the Yard.

On motion, duly seconded, it was unanimously decided that the Entertainment Committee be instructed to draw up a resolution of appreciation for the courtesies shown on the trip, to be sent to the Commandant, and the Secretary was also instructed to write to Commander Carlson's wife expressing the regret of the Association at his illness and stating appreciation of the courtesies extended.

Mr. C. E. Grunsky reported on the proceedings of the conference held in Chicago, Ill., on April 23d to 25th, 1919, under the auspices of Engineering Council, to consider the proposed National Department of Public Works.

After discussion as to whether the Association should express an opinion on the proposed National Department of Public Works, by Messrs. Marx and Grunsky (for) and Dillman (against), the Board of Directors was authorized, on motion, duly seconded, to arrange for statements on the question *pro* and *con*, these statements to be published in the proceedings and sent in advance to the membership for discussion, preliminary to a vote on the matter at a future meeting.

Mr. M. M. O'Shaughnessy, as Chairman, called on the Chairmen of the four Sub-Committees on Development, namely, Technical Activities, External Relations with the Engineering Profession, Internal Relations and Local Associations, and Public Relations—Messrs. Duryea, Grunsky, Rhodin, and Dillman—to direct the discussion of the reports of these Sub-Committees. After a two-hour discussion, the reports, on motion, duly seconded, were adopted with a few minor exceptions.

Adjourned.

Colorado Association, Organized 1908.

W. C. Huntington, President; A. N. Miller, Secretary-Treasurer, 1400 West Colfax Avenue, Denver, Colo.

The meetings of the Colorado Association of Members of the American Society of Civil Engineers (Denver, Colo.) are held on the second Saturday of each month, except July and August. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary. The meetings are usually preceded by an informal dinner. Members of the American Society of Civil Engineers will be welcomed at these meetings.

Weekly luncheons are held on Wednesday, at 12.30 P. M., at Daniels and Fisher's.

Visiting members are urged to attend the meetings and luncheons.

Atlanta Association, Organized 1912.

T. P. Branch, President; J. T. Wardlaw, Secretary-Treasurer, 1530 Healey Bldg., Atlanta, Ga.

Informal luncheons are held for members of the Association on the last Monday of each month, at 12.30 P. M. The place is not fixed, but this information will be furnished on application to the Secretary.

Baltimore Association, Organized 1914.

H. G. Perring, President; Charles J. Tilden, Secretary-Treasurer, The John Hopkins University, Baltimore, Md.

Cleveland Association, Organized 1914.

F. D. Richards, President; George H. Tinker, Secretary-Treasurer, 516 Columbia Building, Cleveland, Ohio.

Detroit Association, Organized 1916.

T. A. Leisen, President; Clarence W. Hubbell, Secretary, 2348 Penobscot Building, Detroit, Mich.

The regular meetings of the Association are held on the second Friday of December, April, and October, the last being the Annual Meeting.

District of Columbia Association, Organized 1916.

A. P. Davis, President; John C. Hoyt, Secretary-Treasurer, U. S. Geological Survey, Washington, D. C.

Duluth Association, Organized 1917.

G. A. Taylor, President; Walter G. Zimmermann, Secretary, Wolvin Building, Duluth, Minn.

The regular meetings of the Association are held at noon on the third Monday of each month (usually at the Kitchi Gammi Club), with luncheon, followed by a short business session and the reading of papers. Visiting members of the American Society of Civil Engineers can secure from the Secretary definite information relative to the meetings, at which they will be welcomed. The Annual Meeting is held on the third Monday in May.

(Abstract of Minutes of Meetings)

July 21st, 1919.—The meeting was called to order at the Kitchi Gammi Club; President G. A. Taylor in the chair; Walter G. Zimmermann, Secretary; and present, also, 18 members and 4 guests.

President Taylor introduced and greeted the guests, Messrs. W. D. Pence, John S. Worley, and Ernest Tupes, of the Federal Valuation Bureau, and W. G. Swart, President of the Duluth Engineers' Club, all of whom responded with short addresses.

The minutes of the meeting of June 16th, 1919, were read and approved.

Mr. J. R. Stack reported for the Entertainment Committee that all bills, except one, in connection with the Annual Convention of the Society, had been paid, and that sufficient funds had been collected to take care of the unpaid amount.

On motion, duly seconded, the Secretary was ordered to send letters of thanks to the Duluth Engineers' Club and the Engineers' Club of Northern Minnesota, expressing the Association's appreciation of their assistance in entertaining the Annual Convention visitors.

President Taylor then expressed his thanks to the Local Committee of Arrangements for the splendid way in which its programme had been carried out, and on motion, duly seconded, a vote of appreciation by the Association was also extended to the Committee.

The Secretary read correspondence from Secretary Charles Warren Hunt and Chairman Calvin W. Rice, relative to the re-employment of discharged soldiers, and, on motion, duly seconded, the matter was referred to the committee on the same subject appointed by the Duluth Engineers' Club.

Mr. John C. Hoyt called the attention of the members to the report of the Committee on Development issued recently, and suggested holding a special meeting of the Association for the purpose of discussing

the report. On motion, duly seconded, Mr. Hoyt was requested to arrange for such special meeting with the Board of Directors and that local Duluth members of the other three Founder Societies be invited to attend the meeting.

President Taylor then called on Messrs. Lyonel Ayres, J. R. Stack, and W. E. Hawley, the Committee appointed to discuss the paper on "Cinder Concrete", presented by Mr. H. E. McCool at the meeting of June 16th, 1919. The discussion was opened by Mr. Hawley and participated in by Messrs. Stack, Swart, Coe, and Pence.

Mr. Ayres, Chairman of the Entertainment Committee, suggested a trip by the Association to the new concrete bridge now being constructed over the St. Louis River, at Fond du Lac, Minn. On motion, duly seconded, it was decided to leave the matter in the hands of the Entertainment Committee, with the suggestion that the trip be made on a Saturday afternoon instead of on a meeting day.

Adjourned.

August 18th, 1919.—The members met at 12 M., at the Duluth Commercial Club, and went by automobile to Fond du Lac, Minn., where lunch was served in the Pavilion. After lunch, the meeting was called to order; President Taylor in the chair; Walter G. Zimmermann, Secretary; and present, also, 17 members and 3 guests.

On motion, duly seconded, all business was laid over until the next meeting, President Taylor having announced that the Entertainment Committee had arranged for this meeting, in order that the members might inspect the new concrete bridge over the St. Louis River, now under construction by St. Louis County and connecting it with Douglas County, which is to be part of the new highway between the Twin Cities and Duluth.

Mr. O. A. Roed, Engineer in Charge of Construction, gave a short description of the bridge and its foundation, after which the party inspected the structure, leaving Fond du Lac for the return trip to Duluth about 4 P. M.

Illinois Association, Organized 1916.

H. J. Burt, President; Edgar S. Nethercut, Secretary-Treasurer, 1735 Monadnock Blk., Chicago, Ill.

The regular meetings of the Association are held on the second Monday of March, June, September, and December, the last being the Annual Meeting. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary.

Louisiana Association, Organized 1914.

Arsène Perrilliat, President; Eugene F. Delery, Secretary, 503 City Hall Annex, New Orleans, La.

The regular meetings of the Association are held at The Cabildo, New Orleans, La., on the first Monday of January, April, July, and October.

Nebraska Association, Organized 1917.

*————————, President; Homer V. Knouse, Secretary-Treasurer, 200 City Hall, Omaha, Nebr.

* Mr. Adna Dobson, the President of the Association, died on May 4th, 1919.

Regular meetings of the Association are held on the first Saturday of each month, except July and August, and at such places as may be appointed from time to time by the Executive Committee. The Annual Meeting is held in Lincoln, Nebr., on the second Friday in January.

Visiting members of the Society are especially urged to communicate with the Secretary when in the city.

Northwestern Association, Organized 1914.

Ralph D. Thomas, President; W. N. Jones, Secretary, City Engineer's Office, City Hall, Minneapolis, Minn.

The meetings of the Association are held bi-monthly, alternating between St. Paul and Minneapolis, on the third Friday of each month. Information as to the time and place of such meetings will be furnished on application to the Secretary.

Philadelphia Association, Organized 1913.

F. Herbert Snow, President; Henry T. Shelley, Secretary, 416 City Hall, Philadelphia, Pa.

The regular meetings of the Association are held at the Engineers' Club of Philadelphia, 1317 Spruce Street, on the first Monday in January, April, and October, the last being the Annual Meeting.

Pittsburgh Association, Organized 1917.

Robert A. Cummings, President; Nathan Schein, Secretary-Treasurer, 1510 Carson Street, Pittsburgh, Pa.

The Annual Meeting of the Association is held on the first Monday in October. The time and place of other meetings are not fixed, but this information will be furnished on application to the Secretary.

Portland (Ore.) Association, Organized 1913.

E. Burslem Thomson, President; C. P. Keyser, Secretary, 318 City Hall, Portland, Ore.

The Annual Meeting of the Association is held on the second Friday in January. Other meetings are called by the President and are usually convened on Friday evenings. The place is not fixed, but this information may be obtained on application to the Secretary. All members of the American Society of Civil Engineers are cordially invited to attend the meetings.

(Abstract of Minutes of Meetings)

July 25th, 1919.—The meeting was called to order at the University Club, at 8 P. M.; President E. Burslem Thomson in the chair; C. P. Keyser, Secretary; and present, also, 4 members.

A letter from Mr. A. D. Flinn, Secretary of Engineering Council, to Mr. G. C. Mason was read, advising that Mr. Philip N. Moore, a member of Engineering Council, was en route to Portland and that he should be fittingly welcomed. In this connection, President Thomson stated that he had written to Mr. Moore, in order to arrange for a meeting of the Association on the occasion of his visit, but had had no response.

A letter was read from Secretary Hunt advising that the Association would probably hear from Capt. Wemple, of San Francisco, Cal., relative to employment for Army engineers.

President Thomson presented the report of his Committee on Publications, and on motion, duly seconded, the report was adopted and ordered sent to the Secretary of the Society.

The attitude of the Association toward the American Association of Engineers, and possible relations with other local engineering organizations, was informally discussed by those present, after which, on motion, duly seconded, the President and the First Vice-President were delegated to represent the Association at the local conference to be held on July 28th, 1919.

On motion, duly seconded, it was voted that the Association go on record as wishing to co-operate with a local engineering council and to instruct the delegates to use their discretion to that end.

Adjourned.

August 1st, 1919.—A meeting of the Board of Directors was called to meet Mr. Philip N. Moore at luncheon at the Multnomah Hotel, at which President Thomson, Secretary Keyser, and Messrs. M. E. Reed and O. E. Stanley were present.

As a member of the Board of Representatives of Engineering Council, and the fact that he has been closely identified with affairs in Washington through war work, Mr. Moore was able to report the progress of engineers in National affairs. Among other things, he suggested increasing the annual dues of all engineers who are related to Engineering Council from $1 to $5, in order to support and maintain an engineering agency in Washington. He also outlined the movement to transform the Department of the Interior into a Department of Public Works and urged the Association, as an organization and its members individually, to encourage the Oregon Senators and Congressmen to favor a movement to place an engineer in the Cabinet at the head of an Engineering Department.

Following the luncheon, Mr. Moore and his party were driven on the Columbia Highway as far as Horsetail Falls.

August 12th, 1919.—The meeting was called to order at the University Club; Vice-President M. E. Reed in the chair; C. P. Keyser, Secretary; and present, also, 18 members.

The minutes of the meeting of the Association of July 25th, 1919, and of the Board of Directors of August 1st, 1919, were read and approved.

Several bills were read and ordered paid.

Mr. J. C. Stevens reported that he had failed in his endeavor to have Frank Branch Riley lecture on "Northwest Scenery" before the Annual Convention of the Society at Minneapolis, Minn., because the attempt was made too late for the Programme Committee to consider it, and also that the plan to bring the 1920 Convention to Portland had been abandoned.

Mr. D. C. Henny reported that he had been notified of his nomination as Director for District No. 12, but no other nominations were reported.

Mr. G. C. Mason reviewed the work of the Development Committee preliminary to final action at its meeting to be convened in September, and moved the adoption of the following motion:

"To carry out the recommendations of the Committee on Development, to the effect that the Local Associations form a 'local affiliation

of the branches of the national technical societies and the local technical societies', I move that a committee of two, consisting of J. C. Stevens and J. P. Newell be appointed from this Local Association.

"And that the Secretary be instructed to invite each of the Local Associations of other National Engineering Societies represented in Portland to appoint a similar Committee to discuss and formulate ways and means of bringing about this proposed local affiliation.

"And, further, that in determining which are the National Engineering Societies for purposes of representation on this joint committee, we accept the requirements for membership in Engineering Council as our guide.

"*Be it further resolved* that in the case of any of the National Engineering Societies not having Local Associations in Portland, but having a local membership of at least five, that then in that case the Secretary communicate with one of these members requesting that he get together with the other local members of his society and appoint a committee the same as though that Society already had a Local Association."

On motion, duly seconded, it was proposed to amend Mr. Mason's resolution by substituting the names of Messrs. Thomson and Reed, the present acting delegates to local conferences, for those of Messrs. Newell and Stevens.

After discussion of the subject, the amendments were withdrawn, and a vote was taken on the original motion and carried.

On motion, duly seconded, the original motion was then reconsidered, and the adoption of the resolution was lost.

On motion, duly seconded, the following motion was carried:

"To consider the general subject of local affiliation of the branches of the National Technical Societies, I move that the committee of two previously appointed (Thomson and Reed) for the purpose of creating an engineering council be instructed to meet with representatives of other national founder societies in order to ascertain and report the best means of carrying such affiliations into effect before any further action be taken regarding an engineering council."

Adjourned.

St. Louis Association, Organized 1888 (Constitution Approved by Board, 1914).

J. A. Ockerson, President; C. W. S. Sammelman, Secretary-Treasurer, 300 City Hall, St. Louis, Mo.

The Annual Meeting of the Association, for the election of officers and for the transaction of business, is held on the fourth Monday in November. Two meetings each year, for the presentation and discussion of technical papers, are held in the Auditorium of the Engineers Club of St. Louis and are open to members of the Associated Societies. Other "get-together" meetings are held regularly for dinner or luncheon on the fourth Monday of each month except July, August, and November.

San Diego Association, Organized 1915.

W. C. Earle, President; R. C. Wueste, Secretary-Treasurer, Bonita, Cal.

Seattle Association, Organized 1913.

L. M. Grant, President; G. A. Collins, Secretary, 1317 L. C. Smith Bldg., Seattle, Wash.

The regular meetings of the Association, with luncheon, are held at the Engineers' Club, Arctic Building, Third Avenue and Cherry Street, at 12.15 P. M., on the last Monday of each month. Informal luncheons are also held at 12.15 P. M., every Monday at the Engineers' Club.

Special evening meetings are held from time to time for the purpose of discussing important topics, and information concerning these meetings may be had by addressing the Secretary. All members in any grade of the American Society of Civil Engineers are cordially invited to attend the meetings when in the vicinity, and, if located in this District for any length of time, their membership in the Association will be appreciated.

Southern California Association, Organized 1914.

George G. Anderson, President; Floyd G. Dessery, Secretary, 511 Central Building, Los Angeles, Cal.

The Southern California Association of Members of the American Society of Civil Engineers (Los Angeles, Cal.) holds regular monthly meetings on the second Wednesday of each month, the December meeting being the Annual Meeting.

Informal luncheons in connection with the Joint Technical Societies of Los Angeles are held at 12.15 P. M., every Thursday at the Broadway Department Store Café.

The by-laws of the Association provide for the extension of hospitality to any member of the Society who may be temporarily in Los Angeles, and any such member will be gladly welcomed as a guest at any of the meetings or luncheons.

Spokane Association, Organized 1914.

Harold J. Doolittle, President; Charles E. Davis, Secretary, City Engineer's Office, Spokane, Wash.

The regular meetings of the Association are held on the second Friday of each month, except July and August. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary.

Visiting members are invited to attend the meetings.

Texas Association, Organized 1913.

R. J. Potts, President; J. H. Brillhart, Secretary, Care, Mosher Mfg. Co. Dallas, Tex.

Utah Association, Organized 1916.

A. B. Villadsen, President, 304 Dooly Bldg., Salt Lake City, Utah.

The Annual Meeting of the Association is held on the first Wednesday in April. The time of other meetings is not fixed, but this information will be furnished on application to the President.

PRIVILEGES OF ENGINEERING SOCIETIES EXTENDED TO MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

Members of the American Society of Civil Engineers will be welcome in the Reading Rooms and at the meetings of many engineering societies in all parts of the world. A list of such societies will be found on pages 41 and 42 of the Year Book of the Society for 1919.

NEW BOOKS*

(From August 1st to August 31st, 1919)

The statements made in these notices are taken from the books themselves, and this Society is not responsible for them.

DONATIONS TO ENGINEERING SOCIETIES LIBRARY

ELECTRIC POWER TRANSMISSION:

Principles and Calculations, Including a Revision of "Overhead Electric Power Transmission". By Alfred Still. 2d Edition. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Publishing Co., Ltd., 1919. 407 pp., illus., tab., 9 x 6 in., cloth. $3.50.

"Overhead Electric Power Transmission" was written to provide a discussion of the fundamental principles and scientific laws determining the correct design of overhead transmission lines, suited to the needs of the office engineer in charge of calculations and specifications. The addition of a chapter on underground conductors has now made it necessary to alter the title. The work has also been thoroughly revised, obsolete matter has been omitted, and new material added.

A TEXT-BOOK OF HEAT ENGINES, VOL. I.

By Andrew Jamieson. 18th Edition, Revised by Ewart S. Andrews. Lond., Charles Griffin & Co., Ltd., 1919. 551 pp. 8 x 5 in., cloth. $3.00. (Gift of J. B. Lippincott Co.)

This volume is a revised edition of Professor Jamieson's "Textbook on Steam and Steam Engines", with the omission of the chapters on steam turbines and boilers. The omitted chapters, with others on thermodynamics, entropy, and internal combustion engines, will appear in Vol. II.

BOILER FEED WATER:

A Concise Handbook of Water for Boiler Feeding Purposes (Its Effects, Treatment, and Analysis). By Percy G. Jackson. Lond., Charles Griffin & Co., Ltd.; Philadelphia, J. B. Lippincott Co., 1919. 102 pp., 7 x 5 in., cloth. $2.00. (Gift of J. B. Lippincott Co.)

This volume is intended to be a reliable, concise, and practical compendium of information on boiler waters and feed water troubles. It is based on the author's long experience as chemist to an English boiler insurance company. Contents: Mineral Constituents; Corrosion; Softening; Selection of Softening Plates; Priming; Scale, Grease, and Overheating; Methods of Analysis; Analysis of Scale; Control Tests for Water Softening; Sampling; Solutions; Appendix: List of Factors; List of Atomic Weights; Clark's Table of Hardnesses.

THE NAVAL ARCHITECT'S, SHIPBUILDER'S AND MARINE ENGINEER'S POCKET-BOOK.

By Clement Mackrow and Lloyd Wollard. 12th Edition. N. Y., The Norman W. Henley Publishing Co., 1918. 760 pp., illus., tab., 7 x 4 in., flexible cloth.

The twelfth edition of this pocket-book appeared 2½ years after the eleventh from which it differs by the correction of errors and the addition of seventeen pages containing supplementing notes on various sections of the book and an article on estimating the weight and cost of a merchant vessel. In addition to the subjects usually discussed in such works, articles on aerodynamics and aeronautics are included.

*Unless otherwise specified, books in this list have been donated by the publishers.

MANUAL OF THE CHEMICAL ANALYSIS OF ROCKS.

By Henry S. Washington. 3d Edition. N. Y., John Wiley & Sons, Inc.; Lond., Chapman & Hall, Ltd., 1919. 12 + 271 pp., 1 pl., tab., 9 x 6 in., cloth. $2.50.

The author's object is to present a selection of methods for the analysis of silicate rocks, especially those of igneous origin, adapted to the needs of chemists, mining engineers, etc., who have not made a particular study of quantitative analysis. The present edition has been thoroughly revised and considerably enlarged.

MECHANICAL DRAWING FOR HIGH SCHOOLS:

A Text with Problem Layouts. By Thomas E. French and Carl L. Svensen. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Publishing Co., Ltd., 1919. 221 pp., illus., tab., 9 x 6 in., cloth.

The object of this book is to present mechanical drawing as a definite educational subject by which the student's power of visualization may be developed and his constructive imagination strengthened, while he is also taught to think exactly, to understand and make mechanical drawings, and to know modern drafting-room practice. The course outlined covers two years' work and is a complete textbook and book of problems.

STUDIES IN THE CONSTRUCTION OF DAM EARTHEN AND MASONRY

Arranged on the Principle of Question and Answer for Engineering Students and Others. By E. R. Matthews. Lond., Charles Griffin & Company, Ltd.; Philadelphia, J. B. Lippincott Company, 1919. 43 pp., 30 illus., 9 x 6 in., paper. $1.50. (Gift of J. B. Lippincott Co.)

This book is intended for students preparing for examinations, especially those for associate membership in the Institution of Civil Engineers, or the Institution of Municipal and County Engineers, or for the degree of bachelor of science in engineering in universities.

MEMBERSHIP

(From August 8th to September 4th, 1919)

ADDITIONS

	Date of Membership.
MEMBERS	
JORDAN, THOMAS ARTHUR. (Engineering Service Co.), 816 Washington Bldg., Los Angeles, Cal.	Mar. 11, 1919
KINGSLEY, MOSES LELAND. Chf. Engr., Graham, Anderson, Probst & White, 11 Hanover Sq., London, W. 1, England	Mar. 11, 1919
ASSOCIATE MEMBERS	
COEYTAUX, CHARLES HENRI. 7 Avenue du Theatre, Lausanne, Switzerland	June 16, 1919
GROOTHOFF, ARNOLD. Bandoeng, Java	Mar. 11, 1919
LEE, LASLEY. Engr., U. S. Geological Survey, 404 Federal Bldg., Tacoma, Wash	Mar. 11, 1919
MCNALLY, FRANK ANGUS. Cons. Structural Engr., 123 West Madison St., Chicago, Ill	April 14, 1919
OLMSTED, HOMER GEORGE. Newkirk, Okla	Mar. 11, 1919
REAGAN, EARL FROST. Supt. of Bldg. Constr., Leonard Constr. Co., Box 334, Toledo, Ohio. (Res., 125 South Jefferson St., Knightstown, Ind.)	June 16, 1919
TILLOTSON, LUTHER RUDOLPH. 1324 Topeka Ave., Topeka, Kans.	June 16, 1919
WHITE, DAVID EWING. Care, Roberts & Schaefer Co., 2064 McCormick Bldg., Chicago, Ill. { Jun.	Nov. 28, 1916
{ Assoc. M.	Mar. 11, 1919
JUNIORS	
HUCKABY, MARION COLUMBUS Care, Dept. of Highways, Covington, La	Oct. 9, 1917

DEATHS

COOPER, THEODORE. Elected Member, March 4th, 1874; died August 24th, 1919.

LEAVENWORTH, GEORGE STEVENS. Elected Associate Member, June 3d, 1903; Member, February 5th, 1907; died August 9th, 1919.

SYKES, GEORGE. Elected Junior, May 1st, 1906; Associate Member, December 4th, 1907; Member, May 12th, 1919; died August 21st, 1919.

Total Membership of the Society, September 4th, 1919, 9 193.

MONTHLY LIST OF RECENT ENGINEERING ARTICLES OF INTEREST

(July 17th to September 1st, 1919)

NOTE.—*This list is published for the purpose of placing before the members of this Society, the titles of current engineering articles, which can be referred to in any available engineering library, or can be procured by addressing the publication directly, the address and price being given wherever possible.*

LIST OF PUBLICATIONS

In the subjoined list of articles, references are given by the number prefixed to each journal in this list:

(2) *Journal,* Engrs. Club of Phila., Philadelphia, Pa.
(3) *Journal,* Franklin Inst., Philadelphia, Pa., 50c.
(4) *Journal,* Western Soc. of Engrs., Chicago, Ill., 50c.
(5) *Journal,* Eng. Inst. of Canada, Montreal, Que., Canada.
(6) *Journal,* Am. Inst. of Archts., Washington, D. C., 50c.
(7) *Gesundheits Ingenieur,* Munich, Germany.
(8) *Stevens Indicator,* Hoboken, N. J., 50c.
(9) *Industrial Management,* New York City, 25c.
(11) *Engineering* (London), W. H. Wiley, 432 Fourth Ave., New York City, 25c.
(12) *The Engineer* (London), International News Co., New York City, 35c.
(13) *Engineering News-Record,* New York City, 15c.
(15) *Railway Age,* New York City, 15c.
(16) *Engineering and Mining Journal,* New York City, 15c.
(17) *Electric Railway Journal,* New York City, 10c.
(18) *Railway Review,* Chicago, Ill., 15c.
(19) *Scientific American Supplement,* New York City, 10c.
(20) *Iron Age,* New York City, 20c.
(21) *Railway Engineer,* London, England, 1s. 2d.
(22) *Iron and Coal Trades Review,* London, England, 6d.
(24) *American Gas Engineering Journal,* New York City, 10c.
(25) *Railway Mechanical Engineer,* New York City, 20c.
(26) *Electrical Review,* London, England, 4d.
(27) *Electrical World,* New York City, 10c.
(28) *Journal,* New England Water-Works Assoc., Boston, Mass., $1.
(29) *Journal,* Royal Soc. of Arts, London, England, 6d.
(32) *Mémoires et Compte Rendu des Travaux,* Soc. Ing. Civ. de France, Paris, France.
(33) *Le Génie Civil,* Paris, France, 1 fr.
(36) *Cornell Civil Engineer,* Ithaca, N. Y.
(40) *Zentralblatt der Bauverwaltung,* Berlin, Germany, 60 pfg.
(41) *Elektrotechnische Zeitschrift,* Berlin, Germany.
(42) *Proceedings,* Am. Inst. Elec. Engrs., New York City, $1.
(43) *Annales des Ponts et Chaussées,* Paris, France.
(45) *Coal Age,* New York City, 15c.
(46) *Scientific American,* New York City, 15c.
(47) *Mechanical Engineer,* Manchester, England, 3d.
(48) *Zeitschrift,* Verein Deutscher Ingenieure, Berlin, Germany, 1, 60 m.
(49) *Zeitschrift für Bauwesen,* Berlin, Germany.
(50) *Stahl und Eisen,* Düsseldorf, Germany.
(53) *Zeitschrift,* Oesterreichischer Ingenieur und Architekten-Verein, Vienna, Austria, 70h.
(54) *Transactions,* Am. Soc. C. E., New York City, $16.
(55) *Mechanical Engineering:* Journal, Am. Soc. M. E., New York City, $10.
(56) *Transactions,* Am. Inst. Min. and Metallurgical Engrs., New York City, $6.
(57) *Colliery Guardian,* London, England, 5d.
(58) *Proceedings,* Engrs.' Soc. of W. Pa., 2511 Oliver Bldg., Pittsburgh, Pa., 50c.
(59) *Proceedings,* American Water Works Assoc., Troy, N. Y.
(60) *Municipal and County Engineering,* Indianapolis, Ind., 25c.
(61) *Proceedings,* Western Railway Club, 225 Dearborn St., Chicago, Ill., 25c.
(62) *American Drop Forger,* Thaw Bldg., Pittsburgh, Pa., 10c.
(63) *Minutes of Proceedings,* Inst. C. E., London, England.
(64) *Power,* New York City, 10c.
(65) *Official Proceedings,* New York Railroad Club, Brooklyn, N. Y., 15c.
(66) *Gas Journal,* London, England, 6d.
(67) *Cement and Engineering News,* Chicago, Ill., 25c.
(69) *Eisenbau,* Leipzig, Germany.
(71) *Journal,* Iron and Steel Inst., London, England.
(71a) *Carnegie Scholarship Memoirs,* Iron and Steel Inst., London, England.

(72) *American Machinist,* New York City, 15c.
(73) *Electrician,* London, England, 18c.
(75) *Proceedings,* Inst. of Mech. Engrs., London, England.
(77) *Journal,* Inst. Elec. Engrs., London, England, 5s.
(78) *Beton und Eisen,* Vienna, Austria, 1, 50m.
(80) *Tonindustrie Zeitung,* Berlin, Germany.
(83) *Gas Age,* New York City, 15c.
(85) *Proceedings,* Am. Ry. Eng. Assoc., Chicago, Ill.
(86) *Engineering and Contracting,* Chicago, Ill., 10c.
(87) *Railway Maintenance Engineer,* Chicago, Ill., 10c.
(89) *Proceedings,* Am. Soc. for Testing Materials, Philadelphia, Pa., $5.
(90) *Transactions,* Inst. of Naval Archts., London, England.
(91) *Transactions,* Soc. of Naval Archts. and Marine Engrs., New York City.
(92) *Bulletin,* Soc. d'Encouragement pour l'Industrie Nationale, Paris, France.
(93) *Revue de Métallurgie,* Paris, France, 4 fr. 50.
(96) *Canadian Engineer,* Toronto, Ont., Canada, 10c.
(98) *Journal,* Engrs. Soc. of Pa., Harrisburg, Pa., 30c.
(99) *Proceedings,* Am. Soc. of Municipal Improvements, New York City, $2.
(100) *Professional Memoirs,* Corps of Engrs., U. S. A., Washington, D. C., 50c.
(103) *Mining and Scientific Press,* San Francisco, Cal., 10c.
(104) *The Surveyor and Municipal and County Engineer,* London, England, 6d.
(105) *Chemical and Metallurgical Engineering,* New York City, 25c.
(106) *Transactions,* Inst. of Min. Engrs., London, England, 6s.
(107) *Schweizerische Bauzeitung,* Zürich, Switzerland.
(109) *Journal,* Boston Soc. C. E., Boston, Mass., 50c.
(110) *Journal,* Am. Concrete Inst., Philadelphia, Pa., 50c.
(111) *Journal of Electricity,* San Francisco, Cal., 25c.
(113) *Proceedings,* Am. Wood Preservers' Assoc., Baltimore, Md.
(114) *Journal,* Institution of Municipal and County Engineers, London, England, 1s. 6d.
(115) *Journal,* Engrs.' Club of St. Louis, St. Louis, Mo., 35c.
(116) *Blast Furnace and Steel Plant,* Pittsburgh, Pa., 15c.
(117) *Engineering World,* Chicago, Ill.
(118) *Times Engineering Supplement,* London, England, 2d.
(119) *Landscape Architecture,* Harrisburg, Pa., 50c.
(120) *Automotive Industries,* New York City, 15c.

LIST OF ARTICLES

Bridges.

An Outline for the Inspection of Steel Bridges. G. A. Haggander. **(87)** Mar.
An Unusual Concrete Highway Bridge.* C. S. Bennett. **(67)** July.
Points Requiring Special Observation and Investigation in Bridge Inspection. Herbert C. Keith. (Paper read before the Brooklyn Engineers' Club.) **(90)** July 17.
Strengthening Old Iron Bridges by Reinforced Concrete Arch Ribs.* A. T. Davis. **(86)** July 30.
Substructure of Michigan Avenue Bascule Bridge, Chicago.* Hugh E. Young and William A. Mulcahy. **(13)** July 31.
Mounted Piledriver Rig Developed by United States Army.* (Pontoon.) **(13)** July 31.
Test of Sandy Foundations at Arch Bridge Pier.* Arthur Richards. **(13)** July 31.
Stress Measurement.* **(12)** Aug. 1.
Elevating Illinois Central Tracks and Building the New Bridges.* W. T. Christine. **(117)** Aug. 1.
Cofferdam Experience at a Bridge in Chicago River.* Hugh E. Young and William A. Mulcahy. **(13)** Aug. 7.
Flat Arches on High Piers, South Side Bridge, Fairmont.* **(13)** Aug. 7.
Hell Gate Bridge, New York.* Frank W. Skinner. **(11)** Aug. 8.
Electricity Cuts Construction-Plant Power Costs.* (Arch Bridge Construction.) **(13)** Aug. 14.
Rondout Creek Bridge Design Condemned for Excessive Load on Batter Piles.* **(13)** Aug. 14.
Cross-River Traffic Problems at Portland.* W. A. Scott. **(117)** Aug. 15.
Extraordinary Repairs Made to a 1 900-Ton Drawbridge.* Thomas D. Fulton. **(13)** Aug. 21.
Mechanical Method for Determining Reactions in Continuous Girders.* R. Fleming. **(13)** Aug. 28.
Timber Bridge Problems on the Alaska Railway.* **(13)** Aug. 28.
Etude sur l'Emploi des Cables aux Armées.* G. Leinekugel le Cocq. **(33)** Serial beginning June 14.
La Stabilité des Ponts sous le Passage des Charges Mobiles: Le Réglement Ministériel francais pour le Calcul et les Epreuves des Pont Métalliques. A. Goupil. **(33)** July 19.

* Illustrated.

Bridges—(Continued).

Die Skuru-Brücke bei Stockholm.* A. Björkmann. (78) Apr. 4, 1916.
Die wirtschaftlich günstige Anordnung einer Brückenanlage auf zeichnerischem Wege.* Robert Schönhöfer. (49) 1918, Pt. 10.
Vorschlag für eine Bogenbrücke ohne Diagonalen.* Franz Kleinhenz. (69) Jan., 1918.
Bogenträger mit zwei Gelenken.* Fr. Engesser. (69) Feb., 1918.
Der Gelenklose Bogen mit Zugband in Beliebiger Höhe.* F. Bohny. (69) Apr., 1918.
Die Sparsame Bemessung der Stützweite von Eisernen Balken-Brücken.* Robert Schönhöfer. (69) Apr., 1918.
Ermittlung der Knicksicherheit Gedrückter Untergurte von Bogenfachwerkbindern bei Verwentlung Gewöhnlicher Walzpfetten.* Kaufmann. (69) June, 1918.
Berechnung von Bogenbrücken bei räumlichem Kraftangriff; Allgemeines rechnerisches und graphisches Verfahren der Berechnung mittels Einflusslinien.* Alfred Hawranek. (78) Serial beginning June 4, 1918.
Betonbrücken aus umschnürtem Gusseisen.* Fritz v. Emperger. (53) Serial beginning Aug. 2, 1918.
Hängebrücke und Schwebefähre in Rio de Janeiro.* Hugo Kulka. (69) Nov., 1918.
Das Versuchswesen in der Praxis des Eisenbaues.* Fritz Hübner. (69) Dec., 1918.
Versuche mit einer Balkenbrücke von 12, 2 m Lichtweite; nach einem Bericht von D. A. Abrams mit Erläuterungen über die Abhangigkeit der Bruchlast von der Scherfestigkeit.* Gerhard Neumann. (78) Serial beginning Mar. 5.
Hängebrücke und Schwebefähre in Rio de Janeiro.* (40) Apr. 2.
Neubau der Petribrücke in Rostock.* Kerner. (40) Apr. 26.

Electrical.

Notes on Surface Condensing Plants, with Special Reference to the Requirements of Large Power Stations.* R. J. Kaula. (77) June.
Motor-Driven Ventilating Fans: Some Criticisms. S. Lees. (26) July 4.
A New Development in Motor Starters.* (12) July 11.
Deptford Electricity Works Revisited.* (26) July 11.
New Kern River Development.* G. E. Armstrong. (27) July 19.
Spain Plans National Transmission Network.* George F. Paul (27) July 19.
Steam *versus* Electricity for Auxiliary Drive.* E. L. Marthéleur. (27) July 19.
Pulling in Conductors with a Crane.* Terrell Croft. (64) July 22.
Power Factor Correction.* J. Humphrey. (57) July 25.
Weagant's Anti-Static Method in Wireless Telegraphy.* E. L. Bucher. (From *Wireless Age.*) (73) Serial beginning July 25.
Design of Industrial Lighting System.* Ward Harrison and H. H. Magdsick. (27) July 26.
Selection of Economical Transmission Route.* P. O. Reyneau. (27) July 26.
Substations for Y-Connected Systems.* A. V. Taylor. (27) July 26.
Selection of an Electric System.* Terrell Croft. (45) July 31.
Heating of Underground Cables.* A. L. Freret. (Paper read before Assoc. of Iron and Steel Elec. Engrs.) (2) Aug.
Hydraulic *vs.* Electric Drive for Steel Mill Auxiliaries.* R. B. Gerheart. (Paper read before Assoc. of Iron and Steel Elec. Engrs.) (2) Aug.
Development of an Airplane Shock Recorder.* A. F. Zahm. (3) Aug.
The Photometric Scale.* Herbert E. Ives. (3) Aug.
Grounded Neutral Transmission Line.* W. E. Richards. (42) Aug.
Order and Amplitude of Harmonics in Voltages Wave Forms with Indicating Instruments.* Leslie F. Curtis. (42) Aug.
Predetermination of Synchronous Phase-Modifier Performance.* Hubert V. Carpenter. (42) Aug.
Some Problems in the Operation of Power Plants in Parallel.* E. C. Stone. (42) Aug.
Theory of Probabilities Applied to Failures of Suspension Insulators.* L. M. Klauber. (42) Aug.
Unification of the Manual and Automatic Telephone Systems.* D. E. Wiseman. (42) Aug.
Chicago's Tunnels for Electric Light and Power Cables.* G. B. Springer. (117) Aug. 1.
Lifting Magnets.* B. F. Fernow. (117) Aug. 1.
Functions of the Condenser in High-Tension Magnetos.* Harry F. Geist. (120) Aug. 7.
The Scientific Problems of Electric Wave Telegraphy. J. A. Fleming. (Cantor Lecture.) (29) Aug. 8.
High Voltage Laboratory at Purdue University.* C. Francis Harding. (27) Aug. 9.
Layout of Modern Switch House.* C. A. Corney. (27) Aug. 9.
Testing Instrument Transformers for Polarity.* Clifford W. Bates. (27) Aug. 9.
Radio-Telephone Development in the Army.* Nugent H. Slaughter and others. (27) Aug. 16.
Selecting Voltage Regulators for Feeders.* Frank Hersey. (27) Aug. 16.

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* Illustrated.

Electrical—(Continued).

Measuring Power Factor with Unbalanced Load.* Willard S. Wilder. (27) Aug. 22.
Analysis of Transmission-Line Construction.* D. D. Ewing. (27) Aug. 23.
Half-Million-Volt Condenser for Testing.* (27) Aug. 23.
Induction Motors Driving Centrifugal Pumps.* Fraser Jeffrey. (64) Aug. 26.
A 32 500-Kva. Waterwheel Generator.* R. B. Williamson. (27) Aug. 30.
Development of Arc Transmitters.* Adrien L. Anderson and Harold F. Elliott. (27) Aug. 30.
Groupes Industriels Actionnés par Moteurs à Explosion, Système Renault.* (33) May 17.
Les Fours de Boulangerie à Chauffage Electrique. F. Loppé. (33) July 26.
Der neue Elektrizitätsgesetz-Entwurf. Max Ried. (53) Serial beginning Apr. 26, 1918.
Wechselrede über Elektrizitätswirtschaft und Wasserkraftnutzung. (53) Serial beginning May 24, 1918.
Die Spitzendeckung für die hydraulischen Neiderdruckwerke in Oesterreich. Friedrich R. v. Merkl. (53) Sept. 6, 1918.
Die vier Grundgrössen der Leitungsberechnung für Drehstromleitungen bei Dreieckschaltung der Verbraucher.* J. Teichmüller. (41) Serial beginning Jan. 30.
Vereinheitlichung der Lochstriefers für Mehrfach-und Maschinentelegraphen.* A. Kruckow. (41) Jan. 30.
Schellenkabelschuhe für veränderliche Querschnitt.* R. Zaudy. (41) Jan. 30.

Marine.

Construction of Steel Barges.* Thomas Leach. (58) June.
Heavy Oil Engines for British Submarine Boats.* (11) July 4.
New Yarrow Destroyers.* (12) July 4.
Light-Weight Concrete (for Ship Building).* W. L. Scott. (11) July 11.
Champlain Dry Dock at Quebec.* Ulric Valiquet. (12) July 25.
The First Round-Trip Trans-Atlantic Airship.* (46) July 26.
Gimbal Stabilization.* V. Bush. (3) Aug.
World's Largest Dry Dock Completed at Portsmouth Navy Yard at Cost of $4 000 000.* (67) Aug.
Pre-Cast Concrete Units.* W. Noble Twelvetrees. (117) Aug. 1.
Some Problems in the Design of Concrete Ships. J. Glaettli, Jr. (Abstract of paper read before Am. Concrete Inst.) (13) Aug. 7.
The Dazzle Painting of Ships.* Norman Wilkinson. (Paper read before North-East Coast Inst. of Engrs. and Shipbuilders.) (11) Aug. 8.
Repairing the Stern Frame of the *Northern Pacific.* (46) Aug. 9.
H. M. S. *Furious.** (11) Aug. 15.
Our Proposed 1 000-Ft. Steamers.* (46) Aug. 16.
Concrete Barge Survives Launching at Singapore.* (13) Aug. 21.
Completion of the Pearl Harbor Dry Dock.* A. Russell Bond. (46) Aug. 30.
Les Ferry-Boats Militaires Franco-Anglais.* G. Mangin. (33) Serial beginning Feb. 22.
Le Navires Inchavirables et Insubmersibles Leparmentier.* Raymond Lestonnat. (33) June 7.
Le Coulage de la Flotte allemande à Scapa-Flow et les Valeurs Relatives des Navires anglais et allemands d'après la Bataille du Jutland (31 mai 1916) : Les Monitors anglais.* A. Poidlouë. (33) July 5.
Der Eisenbetonschiffbau.* (78) Jan., 1918.
Neuere Anwendungen im Eisenbetonschiffbau.* A. A. Boon. (78) Feb., 1918.
Schiffe aus Eisenbeton. (78) Feb., 1918.
Ueber Eisenbetonschiffbauten, mit besonderer Berücksichtigung einer Ausführung der Firma Ed. Züblin & Co.* H. Schürch. (78) Mar. 5, 1918.
Die wichtigsten Patente des In- und Auslandes über den Bau von Eisenbetonschiffen.* O. Ferdinand. (78) Serial beginning Apr. 5, 1918.
Schiffbauten aus Eisenbeton in England.* (78) Aug. 5, 1918.
Zur Frage des Baues von Eisenbetonschiffen. Walther Stross. (78) Sept. 5, 1918.
Ein Schwimmdock für Eisenbetonschiffe.* Fritz von Emperger. (78) Dec. 4, 1918.
Verwendung von Eisenbetonsenkkasten bei der Hafenerweiterung in Kopenhagen.* Christiani and Nielsen. (78) Mar. 5.
Vorschriften für den Bau von Seeschiffen aus Eisenbeton. E. Suenson. (78) Apr. 5.

Mechanical.

The Development and Future of Aviation in Canada.* M. R. Riddell. (5) Mar.
Devices and Methods for Measuring High and Low Temperatures with Special Reference to Engineering Problems.* Herman Henry Albers. (8) Apr.
Report on the Chemical Treatment of Boiler Feed Water. E. Echikson. (8) Apr.
Report on the Lubrication of Sliding Metallic Surfaces.* Harry G. Hiebeler. (8) Apr.
Report on the Relative Sizes of Steam and Return Mains in Steam Heating Apparatus. J. K. Smith. (8) Apr.

* Illustrated.

Mechanical—(Continued).

Some Considerations with Regard to Fuel Gas.* Fred. Crabtree. (58) Apr.
Peat, Oil and Gas Fuel.* B. J. Forrest. (5) June.
The Production of Peat Fuel. Ernest V. Moore. (5) June.
Alcohol as Motor Fuel. (118) July.
Inert Products in Coal Gas. (118) July.
Steam and Coal Consumption in Power Stations.* R. H. Parsons. (11) July 4.
The Voyage of the R 34. (12) July 4.
The Regenerative Effect as Influencing the Lighting Efficiency of the Inverted Incandescent Burner.* J. S. G. Thomas. (From *Journal* of the Soc. of Chemical Industry.) (66) July 8.
Coal-Handling Plant at Nobel's Explosive Factory at Pembrey.* (11) July 11.
Recent Machine Tool Developments. Joseph Horner. (11) Serial beginning July 11.
Some Developments in Aircraft Design and Application During the War.* Lord Weir. (Paper read before the North-East Coast Inst. of Engrs. and Shipbuilders.) (11) Serial beginning July 11.
The "Blackburd" Torpedo-Carrying Aeroplane.* (11) July 11.
A Huddersfield Crane Works.*. (12) July 11.
Notes on Drop Valves for Steam Engines.* H. W. Morley. (12) July 11.
A New Governor for Close Pressure Regulation of Gas Exhausters and Boosters. (105) July 15.
Burning Powdered Coal (The Carburization System).* W. G. Wilcox. (117) July 15.
Accessible Oiling System Features New Allen Engine.* (120) July 17.
Automatic Temperature Control.* (120) July 17.
Plan to Use Exhaust Heat in Vaporization of Low Grade Fuels.* F. C. Mock. (Paper read before Soc. of Automotive Engrs.) (120) July 17.
The Limits of Thermal Efficiency in Diesel and Other Internal Combustion Engines.* Dugald Clerk. (Paper read before North-East Coast Inst. of Engrs. and Shipbuilders.) (11) Serial beginning July 18.
Steam *versus* Electricity for Auxiliary Drive.* E. L. Martheleur. (27) July 19.
The Trans-Atlantic Dirigible.* (46) July 19.
Problems in the Utilization of Fuels. Raymond F. Bacon and William C. Hamor. (From paper read before Soc. of Chemical Industry.) (57) July 25.
Keeping the Big Guns at the Front Effective.* Herbert T. Wade. (46) July 26.
The First Round-Trip Trans-Atlantic Airship. (46) July 26.
Largest Ice Plant in the West.* Victor J. Azbe. (64) July 29.
The Semi-Diesel Engine. H. F. Shepherd. (64) July 29.
A Rapid Unloading Machine.* (45) July 31.
How Welded Electrodes in Spark Plugs Prove Superiority.* J. Edward Schipper. (120) July 31.
Testing Strength of Airplane Wing Ribs 55 to 96 Inches.* Armin Elmendorf. (120) July 31.
Development of an Airplane Shock Recorder.* A. F. Zahm. (3) Aug.
Pitch Pockets and their Relation to the Inspection of Airplane Parts.* J. R. Watkins. (3) Aug.
A. S. M. E. Boiler Code: Part I, Section III.* (55) Aug.
Pulverized Coal as a Fuel.* N. C. Harrison. (55) Aug.
Pulverized Coal for Stationary Boilers.* Fred'k A. Sheffler and H. G. Barnhurst. (55) Aug.
Standards of Carburetor Performance.* (55) Aug.
Suggested Formula for Rating Kerosene Engines.* D. L. Arnold. (55) Aug.
Metal Construction of Aircraft.* A. P. Thurston. (11) Serial beginning Aug. 1.
The Coking of Illinois Coal in Koppers Type Oven.* R. S. McBride and W. A. Selvig. (Bureau of Standards and Bureau of Mines.) (105) Aug. 1.
Splintering of Airplane Woods.* G. E. Heck. (19) Aug. 2.
Alignment Chart for Finding the Properties of Saturated and Superheated Steam.* Clinton E. Pearce. (64) Aug. 5.
The Computation of Combustion Data.* Arthur D. Pratt. (64) Aug. 5.
The Use of Raw Tars as Fuels for Diesel Engines.* Harold Moore. (11) Aug. 8.
Fuel Economy in Power Production.* W. T. Lane. (From *Proceedings,* South Wales Inst. of Engrs.) (57) Aug. 8.
Pump Troubles.* Charles Labbe. (16) Aug. 9.
Advantage of Compression in Internal Combustion Engines.* J. S. A. Johnson. (64) Aug. 12.
Low Temperature Distillation of Coal.* C. M. Garland (64) Aug. 12.
Concrete Fuel-Oil Tank Design and Construction. H. B. Andrews. (Abstract of paper read before Am. Concrete Inst.) (13) Aug. 14.
Aerodynamical Considerations in the Design of a Propeller.* H. Levy. (120) Aug. 14.
Continuous Process for Distilling Coal Tar.* (From *Journal des Usines a Gaz.*) (83) Aug. 15.
Standardized Method for Connecting Gas Mains.* Duncan D. Ransdell. (83) Aug. 15.

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* Illustrated.

Mechanical—(Continued).

A New Method of Distilling Both Green and Seasoned Hardwoods. (For aeroplanes.) **(105)** Aug. 15.
Experimental-Retort Tests of Orient Coal.* R. S. McBride and I. V. Brumbaugh. (Bureau of Standards.) **(105)** Aug. 5.
Insuring Adequate Coal Supply with the Least Expenditure.* George E. Wood. **(17)** Aug. 16.
Kiln-Drying Specifications for Airplane Lumber.* H. D. Tieman. **(19)** Aug. 16.
The Air Receiver. Frank Richards. **(86)** Aug. 20.
Method of Testing Cleanness of Producer Gas. H. F. Smith. **(20)** Aug. 21.
Aircraft Engine with Steel Liners in Aluminum Cylinder Blocks.* **(120)** Aug. 21.
Making a Packing-House Refrigerating Plant Carry Its Load.* J. C. Moran. **(64)** Aug. 26.
Fire Hazards Met in Storage of Fuel Oil. J. W. Lord. (Paper read before Am. Concrete Inst.) **(13)** Aug. 28.
Studies in High Speed Aerodynamic Phenomena.* F. W. Caldwell and E. N. Fales. **(120)** Aug. 28.
When the Compass Goes Crazy. (Aeroplanes.) C. H. Claudy. **(46)** Aug. 30.
Application des Principes de l' Organisation Scientifique à l'Atelier Central de Réparations du Service Automobile.* J. Compagnon. **(92)** Mar.
Les Installations Frigorifiques à Bord des Grands Paquebots.* Léon Lefebvre. **(33)** June 28.
Le Triplan Anglais Tarrant.* **(33)** June 28.
Le Moteur Still à Combustion Interne et a Vapeur.* **(33)** July 12.
Le Décapage au Jet de Sable des Pièces de Fonderie.* F. Couleru. **(33)** July 19.
Les Dirigeables Rigides; la Double Traversée de l'Atlantique par le Dirigeable Anglais R-34.* E. Gouault. **(33)** July 26.
Die Auswahl der Dampfmaschine nach ihrer Bauart. Karl Reinbold. **(80)** Mar. 25, 1916.
Kaufpreis für eine Ziegelei. W. Roloff. **(80)** Mar. 28, 1916.
Zur Berechnung von Schutzbrücken für Drahtseilbahnen. A. Senft. **(40)** Apr. 22, 1916.
Die Zerkleinerung von Kohle und Koks.* A. Mann. **(53)** Sept. 6, 1918.
Die Berechnung der Verbrennungs-oder Generatorgasmenge aus deren Analyse und aus dem Heizwerte der Kohle.* Franz Cástek. **(50)** Jan. 2.
Die menschliche Arbeitskraft ersparenden oder vervielfältigenden Maschinen und Geräte der Landwirtschaft. G. Fischer. **(48)** Jan. 4.
Zur Berechnung von Oelleitungen.* Wittfeld. **(40)** Mar. 1.
Gleisanlagen mit Drehscheiben und Schiebebühnen vor Maschinenhäusern.* **(40)** Apr. 5.
Unterkunfträume für Kraftwagen.* **(40)** Apr. 26.
Die neuen Osterreichischen Vorschriften über Projektierung und Bau von Schwebeseilbahnen für Personenbeförderung. **(107)** May 31.
Universal-Regulierung System Seewer für Hochdruck-Pelton-Turbinen.* Franz Prásil. **(107)** Serial beginning May 31.

Metallurgical.

The Manufacture of Steel for Ordnance Materials in England and in France.* F. F. McIntosh. **(58)** April.
Notes on Heat Treatment of Steel.* T. B. Lynch. **(58)** June.
Continuous Furnace for Heating Forgings.* **(62)** July.
Electric Resistance Heat Treating Furnace.* A. M. Clark. **(62)** July.
The Heat Treatment of Chrome-Nickel Steel.* H. C. Loudenbeck. (From paper read before Steel Treating Research Soc.) **(62)** July.
The Heat Treatment of Grey Cast Iron at Low Temperatures.* J. E. Hurst. **(11)** July 4.
The Manufacture of Cast Steel Road Wheels.* **(12)** July 4.
Electrically Heated Soaking Pits. Thaddeus F. Baily. (Abstract of paper read before the Am. Iron and Steel Inst.) **(22)** July 4.
The Principal Changes in Blast-Furnace Lines.* J. G. West. (Abstract of paper read before Am. Iron and Steel Inst.) **(22)** July 4.
The Thomas & Davies Tinning Machine, Melingriffith Works, Cardiff. **(22)** July 4.
Permanent Moulds.* **(12)** July 11.
A German Blast-Furnace Charger.* **(22)** July 11.
Blast-Roasting and Its Effect on Blast Furnace Design. Walter K. Mallette. **(105)** July 15.
Thermo-Electric Pyrometers for Plant Use.* A. O. Aseman. **(105)** July 15.
Aluminum Alloy Combines Strength with Toughness.* **(120)** July 17.
Electrical Heat Treatment of Steel.* H. P. MacDonald. **(120)** July 17.
The Plastic-Arc Welding System.* **(12)** July 18.
Silver Volatilization in Smelting.* Frederic P. Dewey. **(16)** July 19.
Operating Records of Electric Steel Furnaces.* **(27)** July 19.
Prolonging the Life of the Roofs of Reverberatory Furnaces at Anaconda.* Oliver E. Jager. **(103)** July 19.

* Illustrated.

Metallurgical—(Continued).

An Example of Forge Shop Construction. (20) July 24.
Fusion Welding Applied to Drop Forgings.* S. W. Miller. (Paper read before Am. Drop Forge Assoc.) (20) July 31.
Hydraulic *vs.* Electric Drive for Steel Mill Auxiliaries.* R. B. Gerheart. (Paper read before Assoc. of Iron and Steel Elec. Engrs.) (2) Aug.
Main Hoists for Open Hearth Ladle Cranes. W. W. Garrett. (2) Aug.
Some Remarks Concerning the Heat Treatment of Steel and Their Application to the Treatment of Steels Used for Airplane Motors. Albert Sauveur. (3) Aug.
What is Modern Malleable Iron? H. A. Schwartz. (Paper read before Car Foreman's Assoc. of Chicago.) (25) Aug.
Forging Axles at the Cambria Steel Plant.* A. W. Peterson. (62) Aug.
Heat Treating Furnaces for Heavy Artillery.* William J. Harris. (62) Aug.; (116) Aug.
The Heat Treatment of Steel and Its Uses. George Hutton. (Paper read before International R. R. Master Blacksmith's Assoc.) (62) Aug.
Thermit Welding in Our Railroad Shops.* (62) Aug.
Forming Machine for Shaping Steel Tubes.* (116) Aug.
Modern Steel Metallurgical Calculations.* Charles H. F. Bagley. (From paper read before British Iron and Steel Inst.) (116) Serial beginning Aug.
Notes on Practical Metallographic Methods.* Austin B. Wilson. (116) Aug.
Exposure Tests of Sheeting Material.* Samuel L. Hoyt. (105) Aug. 1.
Flakes in Alloy Steel. Ernest Edgar Thum. (105) Aug. 1.
Deep-Level Development in Aspen.* Frederick W. Foote. (16) Aug. 2.
Experiments in Magnetizing Roasting.* George J. Young. (16) Aug. 2.
Effect of Actions Inside Furnace on Performance.* W. K. Booth. (27) Aug. 2.
Electrolytic Deposition of Copper in the Leaching of Roasted Ore and Concentrate.* Percy R. Middleton. (103) Aug. 2.
The Horwood Process as Applied to the Copper Zinc Ore of the Afterthought Mine.* A. H. Heller. (103) Aug. 2.
A Dayton Foundry of Progressive Design.* (20) Aug. 7.
Limiting of Transverse Rail Fissures. Paul Krenzpointner. (20) Aug. 7.
Welding Wrought Iron and Steel.* H. L. Unland. (20) Aug. 7.
Roasting by the Huntington-Heberlein Process at Cockle Creek, N. S. W. W. J. Jackson. (From *Transactions* of the Australasian Inst. of Min. Engrs.) (103) Aug. 9.
The Corrosion of Metals.* Guy D. Benough. (Fourth Report of Corrosion Commission of Inst. of Metals.) (64) Aug. 12.
Silicon-Manganese from Electric Furnaces. B. G. Klugh. (20) Aug. 14.
Heat Treatment as Applied to Railway Materials. C. B. Bronson. (Abstract of paper read before Am. Steel Treaters' Soc.) (15) Aug. 15.
Fibrous Structure in High Carbon Steel. A. W. Lorenz. (105) Aug. 15.
Relation of Microstructure to Phase Changes in Heat-Treated Aluminum Bronzes.* L. R. Seidell and G. J. Horvitz. (105) Aug. 15.
Blast Furnace Slag. H. J. Love. (117) Aug. 15.
Losses in Furnace Slags.* Edward H. Robie. (16) Aug. 16.
Pulverized Coal for Blast Furnaces.* E. P. Mathewson and W. L. Witherspoon. (From *Bulletin* of Canadian Min. Inst.) (16) Aug. 16.
Monel Metal.* Hugh R. Williams. (19) Aug. 16.
Corrosion-Proof Steels. F. Rowlinson. (46) Aug. 16.
Determination of Magnetite in Matte and Slag.* F. G. Hawley. (16) Aug. 23.
Liberty Engine Welding Plant.* Otis Allen Kenyon. (27) Aug. 27.
Mechanical Properties of Steel and Iron.* (Bureau of Standards.) (20) Aug. 28.
Yttrium Mixed Metal.* J. F. G. Hicks. (From *Journal*, Am. Chemical Soc.) (19) Aug. 30.
The Electric Furnace.* F. Rowlinson. (19) Serial beginning Aug. 30.
Nouveau Type de Laminoir à Cage basculante, Sytème Fawell.* (33) May 31.
La Fabrication des Toles Mince dans la Russie méridionale.* F. Couleru. (33) Serial beginning July 5.
Le Nouveau Haut Fourneau de la Park Gate Iron and Steel Company à Rotherham (Angleterre).* (33) July 19.
Mécanisme de la Trempe des Aciers au Carbone.* (33) June 21.
Ueber die Blaubruchigkeit und das Altern des Eisens.* Fettweis. (50) Serial beginning Jan. 2.
Zum Kleingefüge kalkreicher Schlacken und deren Zerfall.* E. Hollmann. (50) Serial beginning Jan. 16.
"Wassersucher" zum Auffinden schadhafter Stellen an wassergekühlten Hochofenarmaturen. K. Milden. (50) Jan. 23.
Die Verzinnung des Gusseisens.* Ernst A. Schott. (50) Jan. 30.

Military.

Gas Warfare at the Front.* B. C. Goss. (58) May.
High-Burst Ranging. Montague Blundon. (100) May.

* Illustrated.

Military—(Continued).

Reinforced Concrete Shelters of German Hindenburg Line.* Aubrey H. Bond. **(100)** May.
The Barrier Type of Tank Defenses.* A. C. Rubel. **(100)** May.
Design and Construction of the Water Supply System of Camp McClellan, Alabama. Maurice R. Scharff. **(60)** July.
The Design and Operation of the Water Filtration Plant at Camp Meade, Maryland. C. R. Potteiger. **(60)** July.
Accuracy of S. R. S. and F. R. S. Locations. **(100)** July.
Anti-Tank Defenses: Tank Ditch.* **(100)** July.
Final Report of Flash and Sound Ranging Service.* **(100)** July.
Fire and Effect of Modern Artillery.* C. Beard. **(100)** July.
Note on the Accuracy of Sound Ranging Locations.* **(100)** July.
The "Blackburd" Torpedo-Carrying Aeroplane.* **(11)** July 11.
The Aberdeen Chronograph.* (For projectiles.) Herbert T. Wade. **(46)** Aug. 9.
Contribution à l'Etude de l'Essorage et du Pilage du Coton-Poudre.* A. Jupeau. **(92)** Mar.
Le Coulage de la Flotte Allemande à Scapa-Flow et les Valeurs Relatives des Navires anglais et allemands d'après la Bataille du Jutland (31 mai 1916): Les Monitors anglais.* A. Poidlouë. **(33)** July 5.
Verwendung des Betons beim Bau der Kriegerfriedhöfe im Militärkommandebereiche Krakau.* Franz Nemec. **(78)** May 4, 1918.

Mining.

Report of Tests to Determine the Adaptability of Grade III TNT for Shooting Oak Stumps.* W. J. Montgomery. (Bureau of Mines.) **(100)** May.
Report of Tests to Demonstrate the Adaptability of Grade III TNT for Clearing Land or Similar Uses.* W. J. Montgomery. (Bureau of Mines.) **(100)** May.
Experiments with Blast and Pressure Meters and Tests of Explosives.* E. H. Schulz. **(100)** May.
Report on Breaking Concrete Piers with Adobe Shots of Grade III, TNT and 40 Per Cent. Straight Nitroglycerin Dynamite.* A. B. Coates. (Bureau of Mines.) **(100)** May.
Recent Developments in the Coalfields South of Sydney.* J. R. M. Robertson. **(106)** June.
Marble Cliff Quarries Company Now Producing Pulverized Limestone.* **(67)** July.
Methods of Blasting and Explosives to Use.* **(67)** July.
Hydraulic Stowing at Dalzell Colliery. **(22)** July 4.
The Lead of Winding Ropes.* W. J. Heeley. (From paper read before Canadian Min. Inst.) **(57)** July 11.
Ventilation in Shaft Sinking.* H. Joosten. **(57)** Serial beginning July 11.
Blasting Practice in Joplin, Zinc District.* **(86)** July 16.
Importance of the Proper Bonding of Mine Rails.* C. C. Beck. (Paper read before the Kentucky Min. Inst.) **(45)** July 17.
Tests and Comparisons of Various Types of Permissible Explosives.* Joseph C. Thompson. (Paper read before Illinois Min. Inst.) **(45)** July 17.
Electric Coal Drills.* A. H. Telfer. **(22)** July 18.
Placer Mining in Oregon.* A. E. Kellogg. **(16)** July 19.
Impurities in Raw Coal and Their Removal.* F. G. Drakeley. (From paper read before the Past and Present Min. Students' Assoc.) **(45)** July 24.
Operating a Coal-Stripping Plant in Ohio.* S. B. Creamer. **(45)** July 24.
Use of the Dorr Thickener and Classifier in Coal Preparation. **(45)** July 24.
TNT as a Blasting Explosive.* Charles E. Munroe and Spencer P. Howell. **(96)** July 24.
Selection of an Electric System.* (Mine installation.) Terrell Croft. **(45)** July 31.
The Rotary Method of Well Drilling.* Albert G. Wolf. **(16)** Aug. 2.
Skip Changing Device at the Steward Mine.* Oliver E. Jager. **(103)** Aug. 9.
Results Obtained from the Use of the Cement Gun at the Cadogan Mine.* Fred Norman. **(45)** Aug. 14.
Concrete Channel for Stream Over Fractured Mine Outcrop.* Harley A. Coy. **(13)** Aug. 14.
Sealing Formations by Slime-Laden Fluid.* (Well-Drilling.) Seth S. Langley. **(16)** Aug. 16.
Advantages of Electrical Method of Setting Off Blasts.* (From *Du Pont Magazine.*) **(86)** Aug. 20.
Mine Electric Signaling Practice.* Terrell Croft. **(45)** Aug. 21.
A Large Coal Mine on the Allegheny River.* Ralph W. Mayer. **(45)** Aug. 21.

Miscellaneous.

Industrial Illumination.* Geo. K. McDougall. **(5)** Mar.
The Osmotic Purification of Clay. W. R. Ormandy. (Report of lecture delivered before the Ceramic Society.) **(11)** July 11.

* Illustrated.

Miscellaneous—(Continued).

Electrolytic Caustic Soda-Chlorine Cells.* Karl Horine. **(105)** July 15.
Melting Point of Asphalts.* Leland M. Proctor. **(105)** July 15.
The Langmuir Postulates.* Ellwood Hendrick. **(105)** July 15.
A Sliding Hillside at Cleveland.* **(13)** July 24.
Design of Industrial Lighting System.* Ward Harrison and H. H. Magdsick. **(27)** July 26.
The Nelson Electrolytic Chlorine Cell.* C. F. Carrier. (From paper read before Am. Electro-chemical Soc.) **(105)** Aug. 1.
White Arsenic Direct Production. Charles E. Doremus. **(117)** Aug. 1.
What is a Chemical Element?* Frederick Soddy. **(19)** Aug. 2.
The Chemistry of Rubber.* S. C. Bradford. (From *Science Progress.*) **(19)** Aug. 9.
The "Backward Rotation" System of Purification.* (Sulphate making and ammonia losses.) W. S. Curphey. **(66)** Aug. 12.
The Calibration Function in Indicating Instruments.* Frederick J. Schlink. **(11)** Aug. 15.
Electrical Conductivity and Other Properties of Saturated Solutions of Copper Sulphate in the Presence of Sulphuric Acid.* H. M. Goodwin and W. G. Horsch. **(105)** Aug. 15.
Physical Properties of Brines.* E. F. Mueller. (Abstract of paper read before Am. Soc. of Refrigerating Engrs.) **(64)** Aug. 19.
Accounting on "Cost Plus" Contracts.* Ralph W. Horne. **(86)** Aug. 20.
The Need for Complete and Accurate Cost Data. P. W. Pinkerton. **(86)** Aug. 20.
Principles Underlying Determination of "Fair Value". (Report of Committee of Am. Elec. Ry. Assoc.) **(13)** Aug. 28.
Recent Progress in Aerial Photography.* L. P. Clerc. (From *La Science et La Vie.*) **(19)** Serial beginning Aug. 30.
Viscosity.* Nicholas Flamel. (From *La Nature.*) **(19)** Aug. 30.
Les Ressources de nos Forêts Coloniales. H. Boutteville. **(92)** Mar.
La Loi du 23 Avril 1919 sur la Journée de Huit Heures, Historique et Consequences. Paul Razous. **(33)** Serial beginning June 7.
L'Industrie des Pays Neutres en Temps de Guerre. Maurice Bellom. **(33)** June 7.
Das gleichzeitige Vorwärtseinschneiden als Schnellmessverfahren in der praktischen Geometrie. A. Tichy. **(53)** Serial beginning May 10, 1918.
Die Gewinnung des gasförmigen Steckstoffes. M. Dolch. **(53)** Serial beginning May 17, 1918
Volkswirtschaft und Wehrmacht. Max v. Kraft. **(53)** Serial beginning June 28, 1918.
Wissenschaftliche Betriebführung. Victor Frey. **(107)** May 24.

Municipal.

Some Municipal Works and Problems in Hampstead.* O. E. Winter. **(114)** July.
Pittsburgh South Hills Tunnel and Earlier Projects.* **(13)** July 24.
Regional Planning of the Niagara District. Thomas Adams. (Paper read before National City Planning Conference.) **(96)** July 31.
Actual Accomplishments in City Planning in America.* Andrew Wright Crawford. **(2)** Aug.
Modern Housing Standards at Dawson, New Mexico.* Charles F. Willis. **(45)** Aug. 7.
The Lindenlea Garden Suburb and Housing Plan, Ottawa. **(13)** Aug. 28.
Le Démantèlement de l'Enceinte Fortifiée et l'Extension de la Ville de Paris.* L. Biette. **(33)** July 12.
Wohnungsnot und Besteuerungsreform des Hauszinses.* Ottokar Stern. **(53)** Serial beginning June 14, 1918.
Kunstkritische Studie über den Stand der Karlsplatzfrage im Jahre, 1917.* Julius Deininger. **(53)** Serial beginning July 5, 1918.
Die Entwicklung des Stadtbildes von Grodno.* Sinning. **(40)** Mar. 1.
Ein neuer Bebauungsplan der Stadt Köln mit abgeändertem Umlegungsgesetz. J. Stübben. **(40)** Apr. 16.
Zum zehnjährigen Bestehen der Gartenstadt Hellerau bei Dresden.* Bellman. **(40)** Serial beginning Apr. 19.

Railroads.

Sink Holes Cause Trouble on Second-Track Work.* **(87)** Mar.
Specifications for Timber Preservation. (For ties, etc.) **(87)** Mar.
Locomotive Coaling Plants.* J. A. Burnett. **(5)** Apr.
The Mount Royal Tunnel * (Montreal.) J. L. Busfield. **(5)** Apr.
Calculation of Values in D. C. Track Circuit.* A. E. Tattersall. **(21)** July.
Maintenance of Permanent Way. **(21)** Serial beginning July.
Screw Spikes *versus* Dog Spikes. G. Richards. (*Technical Paper No. 190,* Ry. Board of India.) **(21)** July.
Standard Boilers, Gt. Western Railway.* **(21)** July.

* Illustrated.

Railroads—(Continued).

Piston Valve Leakage.* J. T. Wallis. (11) July 4.
Extensive Grade Separation Work at Indianapolis.* (15) July 18.
Simple Mallet Locomotive, Pennsylvania R. R. (18) July 19.
An Unusual Form of Roundhouse Smoke Jack.* (15) July 25.
Heavy Mikado and Mallet Type Locomotives.* (18) July 26.
New Turntable for the Pennsylvania Railroad.* (18) July 26.
The Operation of Railways as an Engineering Problem.* V. I. Smart. (5) Aug.
A. S. M. E. Boiler Code: Part I Section III. (55) Aug.
Civic and Engineering Features of Grade Crossing Elimination.* Allen L. Golinkin. (60) Aug.
The Heat Treatment of Steel and Its Use. George Hutton. (Paper read before International R. R. Master Blacksmith's Assoc.) (62) Aug.
Calculation of Values in A. C. Track Circuits. (21) Aug.
Illinois Central Shops at Burnside, Ill. (62) Aug.
Water Facilities for Southern at Monroe. (87) Aug.
Thermit Welding in Our Railroad Shops.* (62) Aug.
The Reconstruction Program for French Railways.* Robert E. Thayer. (15) Serial beginning Aug. 1.
Elevating Illinois Central Tracks and Building the New Bridges.* W. T. Christine. (117) Aug. 1.
Track Elevation on the Indianapolis Union Railroad.* (13) Aug. 7.
The Design of Modern Locomotive Repair Shops.* Gaustave E. Lemmrich. (15) Aug. 8.
Double Sheathed Box Cars for The Canadian Pacific.* (15) Aug. 8.
The Railways of Venezuela.* Charles W. Jones. (18) Aug. 9.
Miami Flood Works Involve Radical Railway Changes.* (13) Aug. 14.
Carolina, Clinchfield & Ohio Freight Locomotives.* (15) Aug. 15.
Heat Treatment as Applied to Railway Materials. C. B. Bronson. (Abstract of paper read before Am. Steel Treaters' Soc.) (15) Aug. 15.
The Kanawha & West Virginia Builds a New Line.* (15) Aug. 15.
Gypsum Construction for Railway Terminals.* Curtis F. Columbia. (117) Aug. 15.
Piercing the Mountain Barrier between France and Spain.* F. Honoré. (46) Aug. 23.
Double-Track Water-Type Ashpit, Pennsylvania Railroad. (13) Aug. 28.
Locomotive Chaufféé au Charbon Pulvérisé du Great Central Railway (Angleterre).* (33) June 21.
Umbau der Bahnhofsanlagen in Weimar.* Geittner. (49) 1918, Pt. 10.
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* Illustrated.

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Construction of Concrete Pavements.* J. L. Harrison. (67) July.
Bonding New Cement Mortar and Concrete to Old Concrete. W. E. Rosengarten. (Bureau of Public Roads.) (86) July 23.
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Proportion and Reasonable Economy in Rural Road Design.* W. G. Harger. (13) Aug. 14.
Relaying Wood Block in Bridgeport, Conn.* J. S. Crandell. (17) Aug. 16.
High Cost of Maintenance of Light Macadam Highways.* Frederick Stuart Greene. (13) Aug. 21.
Main-Route Highway Construction in New Jersey.* (13) Aug. 28.
Paving of Streets and Aisles, Brooklyn Army Supply Base.* (13) Aug. 28.
Les Chaussées Bitumineuses en Grande-Bretagne et aux Etats-Unis. R. Feret. (43) Mar.

Sanitation.

The Calumet Sag Channel.* W. T. Christine. (117) July 15.
Extraction of Grease from Sewage Sludge at Morley.* F. Turner. (From *The Surveyor.*) (86) July 30.
Sewage Treatment Works of Birmingham and Utilization of Sludge.* John D. Watson. (86) July 30.
Sewage and Dissolved Oxygen in New York Harbor.* Kenneth Allen. (13) July 31.
Sinking a Long Board Mattress in a Narrow Channel.* (13) July 31.
Electrical Treatment of Sewage: The Landreth Direct Oxidation Process.* Henry Jermain Maude Creighton and Benjamin Franklin. (3) Aug.
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Large Concrete Sewer Pipe.* (117) Aug. 1.
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Calumet Pumping Station and Intercepting Sewer.* W. T. Christine. (117) Aug. 15.
Sewage-Treatment Works at Langley Field, Virginia.* Thorndike Saville and Carl L. Weil. (13) Aug. 21.
Nouveau Procédé d'Epuration des Eaux d'Egout par Oxydation au Moyen d'un Courant d'Air.* (33) July 19.
Ausführung der Eisenbetonkonstruktionen für zwei Kläranlagen.* (78) Nov., 1918.
Die neue Entwässerungs-Anlage in Codigoro.* G. Müller. (107) July 5.

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* Illustrated.

Structural.

Notes on the Test of a Girderless Floor.* Peter Gillespie and T. D. Mylrea. (5) Apr.
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Volcanic Tuff and Its Uses.* (100) July.
Solving a Stack-Raising Problem.* Martin Fishback. (16) July 19.
The Stability of Reinforced Concrete Retaining Walls.* F. Zimmerman. (86) July 23.
The Treatment of Factory Roof Timbers. George M. Hunt. (86) July 23.
Curved Drive for Automobiles in Six-Story Garage.* (13) July 24.
Seventy-Foot Concrete Flagpole Poured Erect in Place.* R. C. Hardman. (13) July 24.
Steel and Concrete Framing Combined for Economy.* (13) July 24.
Sectional Concrete Cribbing Displaces Retaining Walls at Embankments.* (45) July 24.
Analysis and Tests of Statically Indeterminate Structures.* Mikishi Abe. (Abstract from *Bulletin* issued by Univ. of Illinois.) (86) July 23.
Experiments with Clay in Its Relation to Piles. Alfred S. E. Ackermann. (From *The Surveyor.*) (86) July 30.
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The Manufacture of Cement at Bellevue, Mich.* C. M. Wright. (67) Aug.
What Causes Decay of Structural Timber.* E. E. King. (87) Aug.
Gravel Concrete Unsatisfactory for Fireproofing. (Report of Committee read before Am. Concrete Inst.) (117) Aug. 1.
Modern Daylight Factories.* Albert M. Wolf. (117) Aug. 1.
Compares Strength of Long-Used and Freshly-Cut Douglas Fir. Arthur C. Alvarez. (From *Bulletin* issued by Univ. of California.) (13) Aug. 7.
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Keeping the Costs of Building the Government Houses.* John C. Prior and Herbert P. Green. (13) Aug. 7.
Portable Pneumatic Grain Elevator, Duckham System.* George Frederick Zimmer. (11) Aug. 8.
Bolts in Field Connections of Steel Frame Buildings; a Study of Data and Experience.* R. Fleming. (13) Aug. 14.
Diagram for Locating Stirrups in Concrete Beams.* M. J. Lorente. (13) Aug. 14.
Effect of Rodding Concrete.* F. E. Giesecke. (96) Aug. 14.
Formulæ for One-Story and Two-Story Bents.* E. Maerker. (96) Aug. 14.
Slag as a Structural Material.* (103) Aug. 16.
Telescopic Foundation Caissons Sunk in Bank Basement.* Frank H. Eastman. (13) Aug. 21.
Calcul de l'Effort du Vent dans les Toitures en Arc.* F. Grua. (33) May 31.
L'Augmentation des Taux Limites de Résistances.* Ch. Lemaire. (33) June 28.
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Neuere Bauten der Stadt Frankfurt am Main.* Schaumann. (40) Apr. 1, 1916.
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Knickfestigkeit bei elastischer Querstützung.* G. Unold. (40) Apr. 12, 1916.
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Von der Schrumpfarbeit am Fachwerk.* Leopold Ellerbeck. (49) 1918, Pt. 10.
Der zweistielige symmetrische Dreifeldträger.* W. L. Andrée. (69) Jan., 1918.
Die Berechnung der Einflusslinien für die Stützmomente von Durchlaufenden Balken auf Drei, Vier, Fünf und Mehr Stützen unter Berücksichtigung der Mohrschen Einmomentengleichung.* Kaufmann. (69) Jan., 1918.
Eiskeller.* Wilcke. (78) Jan. 1918.

* Illustrated.

Structural—(Continued).

Zukunftsfragen des Eisenbetonbaues. A. Kleinlogel. **(78)** Jan. 1918.
Festigkeitsberechnung Rechteckiger Steifrahmen.* M. Weizel. **(69)** Feb. 1918.
Versuche und untersuchungen über den Knickwiderstand des Seitlich Gestützen Stabes.* Fr. Engesser. **(69)** Feb. 1918.
Verzeichnis der Abhandlungen Engessers. **(69)** Feb. 1918.
Automobilfabrik in Prag-Lieben.* J. Polivka. **(78)** Feb., 1918.
Tafeln und Normalien für Gelenkpfetten.* Alfred Gregor. **(69)** Mar., 1918.
Ueber die Drehungsbeanspruchung Rechteckiger Kastenquerschnitte.* A. Eggenschwyler. **(69)** Mar. 1918.
Das Schiedsgutachten. **(78)** Mar. 5, 1918.
Materialbedarf, Korngrösse der Zuschlagstoffe und Dichtigkeit des Betons.* Vieser. **(78)** Apr. 5, 1918.
Webereigebäude in Norrköping.* David Andersson. **(78)** Apr. 5, 1918.
Zukunftsfragen des Eisenbetons. Hager. **(78)** Apr. 5, 1918.
Stützenfussausbildungen.* Alfred Gregor. **(69)** May, 1918.
Ueber die Knickfestigkeit von Trägerflanschen und Saumwinkeln.* A. Eggenschwyler. **(69)** May, 1918.
Bestimmung einseitig gedrückter oder gezogener Eisenbetonquerschnitte ohne und mit Berücksichtigung der Betonzugfestigkeit. E. Elwitz. **(78)** Serial beginning May 4, 1918.
Biegung mit Achsialkraft (Reinforced Concrete).* Erich Turley. **(78)** May 4, 1918.
Ueber die Dachform von Eisenbetonbauten.* **(78)** May 4, 1918.
Anwendung von Differenzengleichungen in der Statik Hochgradig Statisch Unbestimmter Tragwerke.* D. Grüning. **(69)** June, 1918.
Anordnung der Schubbewehrung beim Plattenbalken.* Th. Gesteschi. **(78)** June 4, 1918.
Die Druckfestigkeit als Gütemasstab für Beton.* F. v. Emperger. **(78)** June 4, 1918.
Festigkeits- und Bruchversuche mit Duplex-Oberlichtplatten.* **(78)** June 4, 1918.
Beitrag zu der Theorie des Beliebig Gestalteten Einfachigen Rahmens.* H. Maier-Liebnitz. **(69)** July, 1918.
Ueber die Berechnung der Dünnen Kreisplatte mit Grosser Ausbiegung.* Karl Federhofer. **(69)** July, 1918.
Diagonal-Betoneisen in Oesterreich.* **(78)** July 4, 1918.
Die Beziehungen zwischen Formänderung und Biegungsmoment bei Eisenbetonbalken. F. v. Emperger. **(78)** Serial beginning July 4, 1918.
Getreidesilos in Eisenbeton.* G. Escher. **(78)** July 4, 1918.
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Bemerkungen zur Kerbschlagprobe.* P. Fillunger. **(53)** July 26, 1918.
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Die Erzielung einwandfreier Ansichtsflächen von Eisenbetonbauwerken. Erich Brentrup. **(78)** Aug. 5, 1918.
Gekurvte Bordsteine aus bewehrtem Beton.* P. Boemen. **(78)** Aug. 5, 1918.
Gutachten des Oesterr. Ingenieur- und Architekten- Vereines, betreffend Sparmassnahmen im Eisenbetonbau. Fritz v. Emperger. **(53)** Aug. 30, 1918.
Beitrag zur Berechnung des Mehrfelderigen, Gestielten Balken.* J. Melan. **(69)** Sept., 1918.
Beitrag zur Klarlegung der Knickverhältnisse bei dem aus Vier Stäben Bestehenden Rahmen.* E. Elwitz. **(69)** Sept., 1918.
Die Querdehnungen längsbeanspruchter Stäbe und die Poissonsche Zahl.* Fr. Engesser. **(78)** Sept. 5, 1918.
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Zu den Ursachen der Beschädigungen und des Absturzes zweier Platten der Labradorverkleidung des Palastes "Koruna" in Prag.* J. J. Jolivka. **(78)** Sept. 5, 1918.
Gutachten des Oesterr. Ingenieur- und Architekten-Vereines, betreffend eine Erhöhung der zulässigen Inanspruchnahme des Eisens.* Wilhelm Hauser. **(53)** Sept. 20, 1918.
Berechnung Eiserner Fachwerksgebäude bei Anordnung eines in der Dachebene Liegenden Gekrümmten Giebelwandwindträgers.* Alfred Gregor. **(69)** Oct., 1918.
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Bauweise "Schnell".* **(78)** Oct. 5, 1918.
Beitrag zur Bestimmung der Haupt- und Schubspannungen im Eisenbetonbalken bei wandernden Einzellasten.* Rudolf Schuhmann. **(78)** Oct. 5, 1918.
Kunstform und Betonbau.* Martin Mayer. **(78)** Serial beginning Oct. 5, 1918.
Das Landes-Krankenhaus in Graz.* Karl Hupfer. **(53)** Serial beginning Oct. 11, 1918.
Holzbetonbauweisen. Richard Kafka. **(78)** Nov., 1918.

* Illustrated.

Structural—(Continued).

Spannungsermittlung bei Eisenbetonbalken mit ungleichmäsigem Querschnitt mit Hilfe des Zentrifugalmomentes und der Nullinie.* G. Hartschen. (78) Nov., 1918.
Vorschriften für die Prüfung und Lieferung bituminöser Massen, soweit sie im Strassen-, Tief- und Hochbau Verwendung finden. Viktor Mautner. (78) Nov., 1918.
Berechnung der umschnürten Eisenbetonsäulen.* Max R. v. Thullie and Adam Kuryllo. (78) Dec. 4, 1918.
Flüssige Betongemische für Eisenbeton.* F. Brumlik. (78) Dec. 4, 1918.
Neubau der Tribünenanlage des Wiener Trabrennvereins.* Josef. Ant. Spitzer. (78) Dec. 4, 1918.
Bericht des Trägertypen-Ausschuss.* (53) Dec. 13, 1918.
Richtlinien bezüglich Sparmassnahmen im Bauwesen, insbesondere in dem Verbrauch von Eisen und Zement. (53) Feb. 21.
Der Hohlblockbau. Fritz v. Emperger. (78) Mar. 5.
Getriedesilos in Eisenbeton.* G. Escher. (78) Mar. 5.
Rahmenberechnung mit Einflusslinien zur Ermittlung von statisch unbestimmbaren Grossen bei gemischter Belastung. E. Preinfalck. (78) Mar. 5.
Verteilung des Druckes im rechteckigen, zuglosen Querschnitte.* G. Barkhausen. (40) Mar. 8,
Görlitzer Arbeiterwohnungen am Wohnhofe.* Küster. (40) Mar. 29.
Zeitgemässe Bauverträge. Gaber. (40) Mar. 29.
Die wirtschaftlich günstigste Anordnung von Traggebilden mit Stützen von gleichen Kosten.* Robert Schönhöfer. (78) Serial beginning Apr. 4.
Brandproben an Eisenbetonbauten. Henne. (78) Apr. 4.
Der Einfluss des Krieges auf laufende Bauverträge. Hans Sperl. (78) Apr. 4.
Wände nach der Lean-Bauweise.* Torsten Nordell. (78) Apr. 4.

Topographical.

Topographical Surveying in Atacama Desert in Chile.* B. L. G. Rees. (13) July 31.
Topographie und Topoplastik.* F. Becker. (107) July 5.

Water Supply.

Sooke Lake Water Supply, Victoria, B. C.* C. H. Rust. (5) June.
The General Principles of the Development and Storage of Water for Electrical Purposes.* J. W. Meares. (77) June.
Design and Construction of the Water Supply System of Camp McClellan, Alabama. Maurice R. Scharff. (60) July.
The Design and Operation of the Water Filtration Plant at Camp Meade, Maryland. C. R. Potteiger. (60) July.
Some Features of Hydro-Electric Engineering Practice and Possibilities. H. de B. Parsons. (60) July.
Safeguarding the Water Supply for New York City.* Frank E. Hale. (Abstract of paper read before Municipal Engrs. of the City of New York.) (117) July 15.
Convenient Method of Calculating Trash Racks.* E. Balbach. (96) July 17.
Regulating Storage Reservoir on the Upper Murray River. (12) July 18.
The New Madison Water Works.* (64) July 22.
Backfilling Tunnel Through Holes Bored from Surface.* J. Armstrong. (13) July 24.
Diagrams for Excess Loss of Head in Pipe Lines.* Frank S. Bailey. (13) July 24.
Hexagonal Chart for Finding Velocity of Water in Pipes.* C. Warrington Anthony. (13) July 24.
Large Concrete-Cased Steel Pipe Laid in One Piece.* (13) July 24.
Lining a Reservoir with Concrete by the Cement Gun.* E. Court Eaton. (13) July 24.
Point St. Charles Filtration Works, Montreal.* (96) July 24.
Water Waste Control by House Inspections with District Metering.* E. D. Case. (96) July 24.
Studies in the Bacteriology of Water. Denis B. Wood. (From paper read before Inst. of Water Engrs.) (96) July 31.
Curtailing Water Waste and Fixing Equitable Rates at Sault Ste. Marie. W. M. Rich. (Paper read before League of Michigan Municipalities.) (60) Aug.
Design Features and Form of Contract for Constructing a Large Earthern Water Supply Dam on Cost Plus Fee Basis.* Jacob L. Crane and J. G. Kimmel. (60) Aug.
How the Water Supply for 6 000 000 People is Made Safe.* Wm. W. Brush. (60) Aug.
St. Paul Covered Reservoir.* (67) Aug.
New England Hydroelectric Developments.* (117) Aug. 1.

* Illustrated.

Water Supply—(Continued).

Construction Costs of Rice Rips Station.* J. A. Leonard. (27) Aug. 2.
Graphical Method for Estimating Storm-Water Run-Off.* Ralph W. Horner. (13) Aug. 7.
Reconstruction of the Naches-Selah Irrigation Canal.* Elbert M. Chandler. (13) Aug. 7.
Riveted Joints for Steel Penstocks and Tanks.* H. A. Babcock and J. R. Montague. (96) Aug. 7.
Miami District Completes Conduits Under Dams.* (117) Aug. 15.
Construction Details of the Lindsay-Strathmore Irrigation District, California.* E. Court Eaton. (13) Aug. 21.
Hydraulicking Dam Embankment on Miami Flood-Control Project. (13) Aug. 21.
Hydro-Electric Development on the Seguin River.* (96) Aug. 21.
Induction Motors Driving Centrifugal Pumps.* Fraser Jeffrey. (64) Aug. 26.
Rebuilding of a Small Hydro-electric Station.* (27) Aug. 30.
Formes et Dimensions des Grands Barrages en Maçonnerie.* Résal. (43) Mar.
Les barrages automatiques: Barrage automatique de l'usine de Tremp (Espagne).* F. Froté. (33) May 31.
Filtres à Grand Débit et à Nettoyage pour l'Epuration des Eaux Potables, Système Henry Desrumaux.* A. Bidault des Chaumes. (33) June 7.
Le Régime Légal des Chutes d'Eau en France. G. Tochon. (33) Serial beginning July 12.
Le Barrage à Voutes Mutiples en Béton Armé de San Dieguito (Californie).* (33) June 7.
La Station Centrale de Seros (Espagne). Turbines Hydrauliques Verticales Escher Wyss de 14 500 Chevaux.* (33) June 28.
Die Wasserturm für die Papierfabrik Jannowitz i. R.* Wilhelm Iwand. (78) Apr. 4, 1916.
Das neue Flussbau-Laboratorium der Technischen Hochschule Dresden.* Hubert Engels. (40) Apr. 15, 1916.
Die Talsperre bei Malter in Sachsen.* Sorger. (40) Apr. 19, 1916.
Gewolbte Talsperren.* Ziegler. (78) Feb., 1918.
Die bayerischen Wasserkräfte und die Elektrizitätsversorgung von Bayern. Oskar v. Miller. (53) Mar. 29, 1918.
Wechselrede über Elektrizitätswirtschaft und Wasserkraftnutzung. (53) Serial beginning May 24, 1918.
Wasserbehälteranlage in Eisenbeton mit 18 000 m³ Fassungsraum.* A. Jackson. (78) Aug. 5, 1918.
Versuche zur Verhütung von Kolken an Wehre. Thürnau. (40) Mar. 15.
Die Wasserkraftanlage in der Weser bei Bremen.* Kölle. (40) Mar. 18.
Das Elektrizitätswerk Massaboden bei Brig der Schweiz. Bundesbahnen.* H. Eggenberger and A. Dänzer. (107) Serial beginning June 14.

Waterways.

Suggested Harbour Improvements for Greater Montreal.* E. S. M. Lovelace. (5) Apr.-June.
New Concrete Terminals at Norfolk.* (67) July.
Bignell-Jones Premolded Reinforced Concrete Pile.* O. V. P. Stout. (117) July 15.
Norfolk and Mare Island Navy Yards Floating Revolving Cranes Lift 150 Tons.* (117) July 15.
Excavation Methods on the Miami Conservancy Project.* G. L. Teeple (86) July 16.
Suggested Standard Concrete Wharf.* C. R. Coutlee. (96) July 17.
Harbor Facilities and Development at Houston, Texas.* (13) July 24.
Bucket Dredger for Winning Platinum Bearing Soil.* (12) July 25.
Moving Three Large Steel Tanks 150 Miles by Water.* A. J. Taylor. (13) July 31.
Stone-Shipping Dock is Patterned After Ore-Bin Type.* (67) Aug.
Protecting River Banks with Steel Jetties.* F. T. Morse. (87) Aug.
Miami Flood Works Involve Radical Railway Changes.* (13) Aug. 14.
Block Yard Cheaply Improvised from Old Equipment.* (13) Aug. 21.
Creosote Piles Still Sound After 29-Year Service.* (13) Aug. 21.
Duluth Ore-Dock is the Largest in the World.* W. H. Hoyt. (15) Aug. 22.
An Automatic Iron-Ore Unloader.* (16) Aug. 23.
Foundations in Quicksand and Watery Gravel. (13) Aug. 28.
Paving of Streets and Aisles, Brooklyn Army Supply Base.* (13) Aug. 28.
Protecting the Banks of Savannah River Through Augusta.* E. C. Garvin. (13) Aug. 28.
Les ports français et la guerre: Dunkerque.* Auguste Pawlowski. (33) May 31.
L'Aménagement Hydraulique du Rhone français. Force Motrice, Navigation, Irrigation.* Auguste Pawlowski. (33) June 14.
Les Travaux d'Extension du Port de Suez.* Jondet. (33) June 28.

* Illustrated.

Waterways—(Continued).

Murs de Quais en Béton Armé et Travaux de Réparation dans Quelques Ports des Indes Néerlandaises.* A. Goupil. (33) July 5.

Fünfzig Jahre Elbstrombauverwaltung.* Roloff. (40) Apr. 1, 1916.

Senkung und Auffüllung der Grunewaldseen; Durchlässigkeit der Seebetten. H. Keller. (40) Apr. 8, 1916.

Unregelmässige Strömungen. Jasmund. (49) Serial beginning, 1918, Pt. 4.

Vorschläge zum weiteren Ausbau der Weichsel zur Förderung der Schiffbarkeit. A. Niese and G. E. Schmidt. (49) 1918, Pt. 4.

Technisch-geologisches über den Durchstich von Wasserscheiden, inbesondere im Panama-und Donau-Oder-Kanal.* Vincenz Pollack. (53) Serial beginning Feb. 1. 1918.

Die Ausgestaltung der Donauregulierung bei Wien und die Idee eines neuen Donaustadtteiles am linken Ufer.* H. Goldemund. (53) May 10, 1918.

Umschau auf dem Gebiete der Hydrologie.* Friedrich Schaffernak. (53) Serial beginning May 31, 1918.

Ein Dockkran mit neuartigem Längsund Querfahrwerk.* Vladislav Sykora. (48) Jan. 4.

Die nutzbaren Bodenschätze des Lahngebietes als Grundlagen des Lahnkanals.* Joh. Ahlburg. (50) Serial beginning Jan. 9.

Ueber die Berechnung von Flutwellenlinien in einem Tideflusse.* J. Oeltjen. (40) Mar. 29.

* Illustrated.

PAPERS AND DISCUSSIONS

SEPTEMBER, 1919

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CONTENTS

Discussions: PAGE

On a New Principle in the Theory of Structures.
By Messrs. William H. Burr and A. C. Janni 613

The East Canyon Creek Dam.
By Herbert E. Bellamy, M. Am. Soc. C. E. 625

Sewage and Wastes Disposal for the United States Army.
By Messrs. Edmund B. Besselievre and George T. Hammond 633

Water Supply for the Camps, Cantonments, and Other Projects Built by the Construction Division of the United States Army.
By Messrs. George W. Fuller, P. H. Norcross, Clarence Goldsmith, T. Kennard Thomson, W. P. Mason, J. Waldo Smith, E. T. Thurston, K. M. Boorman, William J. Boucher, Morris Knowles, H. F. Dunham, George A. Johnson, F. R. Harris, and Maurice R. Scharff 649

Memoirs:

Hermon Charles Allen, M. Am. Soc. C. E. 675
Holland Williams Baker, M. Am. Soc. C. E. 676
James Currie Hallock, M. Am. Soc. C. E. 678
Arthur Haviland, M. Am. Soc. C. E. 680
Tien Yow Jeme, M. Am. Soc. C. E. 681
Robert Emmet McMath, M. Am. Soc. C. E. 694
Henry Kinder Owens, M. Am. Soc. C. E. 697
Hermann Frederick August Schussler, M. Am. Soc. C. E. 699
Fred Caswell Stanton, M. Am. Soc. C. E. 701
Gustavo Adolfo Dubois, Assoc. M. Am. Soc. C. E. 702
Robert Dwiggins Monteith Henley, Assoc. M. Am. Soc. C. E. 704
Paul Robert Kirstein, Assoc. M. Am. Soc. C. E. 705
Adelbert Philo Mills, Assoc. M. Am. Soc. C. E. 706
Allen Eugene Nichols, Assoc. M. Am. Soc. C. E. 708
Dean Chase, Jun. Am. Soc. C. E. 709
Ernest Charles Dedicke, Jun. Am. Soc. C. E. 711

For Index to all Papers, the discussion of which is current in *Proceedings,* see the end of this number.

AMERICAN SOCIETY OF CIVIL ENGINEERS
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PAPERS AND DISCUSSIONS

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ON A NEW PRINCIPLE IN THE THEORY OF STRUCTURES

Discussion*

By Messrs. William H. Burr and A. C. Janni.

Mr. Burr.

William H. Burr,† M. Am. Soc. C. E. (by letter).‡—This interesting paper is devoted to the establishment and application of what is stated to be a new principle in the determination of stresses and strains in that class of structures in which the axes of members are subject to angular displacement due to stresses of flexure or bending, as arched ribs or simple beams, and trusses with members subjected to bending as well as direct stresses. If any new principle leading to simpler forms of treatment for such structures can be established, it certainly will be welcomed. This discussion is not intended to be a detailed consideration of the subject matter of Professor Swain's paper, but rather to make some simple suggestions regarding the fundamental features of the author's analysis.

Apparently the basic idea on which the new principle is founded is that involved in the establishment of Equations (3) and (4) of the paper. It is to be observed that Equation (3) is established by first using a unit moment, that is, by applying a couple to the given section the moment of which is unity. Under the action of that unit moment, the stress of tension or compression, r, is produced. Equation (3) then legitimately follows from the preceding unnumbered equation, by introducing "(change of length)" due to the stress or stresses produced by the actual loads on the structure.

* Discussion of the paper by George F. Swain, Past-President, Am. Soc. C. E., continued from August, 1919, *Proceedings*.

† New York City.

‡ Received by the Secretary, August 9th, 1919.

Mr. Burr.

Let the case of beams or members subjected to bending only be considered. The second member of the author's Equation (3), with the summation sign removed, is to be applied in succession to each section throughout the entire beam, making it necessary to suppose the application of the unit moment to each such section, otherwise, the proper proportionate relation between r and "(change of length)" would not exist. On page 78* of the paper, however, a value of r is written, which results from the application of a moment, M_r, which, in general, has a value quite different from unity. The resulting expression for the angular displacement is Equation (1), which is the second term of the second member of the author's Equation (4):

$$\alpha = \sum \frac{M_s M_r \, d\, l}{E\, I} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

It is clear, therefore, that the analytical error due to using the stress, r, produced by the moment, M_r, instead of a moment unity, has been introduced in the analysis. In other words, the M_r appearing in the author's Equation (4) should be considered unity, making Equation (1) identical with the old standard formula for angular displacement, which will be recognized at once in Equation (2):

$$\alpha = \sum \frac{M \, \Delta \, l}{E\, I}; \text{ or } \int \frac{M \, d\, x}{E\, I} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

The results of this analytic error can be pointedly shown by the following two illustrations. In Equation (9), of the author's paper, he makes an application of the "new principle" to a beam simply supported at each end and carrying a load at any point, the expression for the angular rotation or displacement being taken at the right-hand end of the beam. The moment, M_r, varies uniformly from unity at the right-hand end of the beam to 0 at the left-hand end. If the load, P, is placed at the center of the span, the angular displacement at the right-hand end of the beam becomes:

$$\alpha_1 = \frac{P\, l^2}{16\, E\, I} = \frac{\frac{1}{2} P \left(\frac{l}{2}\right)^2}{2\, E\, I} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Each half of such a beam is a cantilever, loaded at its free end with $\frac{1}{2} P$, the fixed end of the cantilever being at the center of span of the beam. The angular displacement of the free end of such a cantilever in reference to its fixed end may be found by taking one-half of α_1, given by Equation (3), for the reason that the summation or integration shown by Equation (3) covers the entire beam, the length of which is twice that of the cantilever. This will make the angular rotation for the free end of the cantilever shown by Equation (4),

* *Proceedings*, Am. Soc. C. E., March, 1919.

which is one-half only of the correct value shown by the author's Equation (7): Mr. Burr.

$$\alpha = \frac{\alpha_1}{2} = \frac{\frac{1}{2} P \left(\frac{l}{2}\right)^2}{4 E I} \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

This half value is due to the author's M_r uniformly decreasing from unity to 0. If M_r were displaced by the moment unity, the true value of angular rotation for the free end of the cantilever would result at once.

Again, the author's method may be used to determine the work expended in bending a beam subjected to loading at right angles to its axis. The stress, s, due to bending only, is given in the second term of the second member of the third unnumbered equation preceding Equation (4) of the paper. That value substituted in the author's Equation (3), after writing da for A and dl for l, will give Equation (5):

$$\alpha = \sum \int \frac{r M_s y \, d \, l}{E I} \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

The value of r is:

$$r = \frac{M_r y}{I} d \, a \ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Equation (5) may then be written:

$$\alpha = \sum \int \frac{M_s M_r (y^2 \, d \, a) \, d \, l}{E I^2} \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

The expression, $\int y^2 \, d \, a$, is, of course, the moment of inertia, I, of the cross-section of the beam. Hence, Equation (7), and also Equation (1), may be written:

$$d \, \alpha = \frac{M_s M_r \, d \, l}{E I} \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

The work performed throughout the entire beam will then be shown by Equation (9):

$$\text{Work performed} = \int \frac{M_s \, d \, \alpha}{2} = \frac{1}{2 E I} \int M_s^2 \, M_r \, d \, l \ldots\ldots (9)$$

The correct usual expression for the work performed in bending a beam, that is, the resilience, is as shown in Equation (10):

$$\text{Work performed} = \frac{1}{2 E I} \int M_s^2 \, d \, l \ldots\ldots\ldots\ldots (10)$$

Equation (9), therefore, is correct only when M_r is unity.

Although the preceding criticism relates only to members or beams subjected to flexure, obviously the use of the author's Equation (3) is limited in its applications to those cases only in which the stress, r,

Mr. Burr. is produced by the application of a couple with a unit moment to the sections covered by the summation.

It may be justly urged that since the moment, M_r, must be considered unity, its use as an analytic device is superfluous and unnecessary. So far as members subject to flexure only are concerned, nothing could be simpler or more direct in application than the old and standard formula given by the writer's Equation (2). This formula has been used, for many years, for angular displacement or rotation of the longitudinal axis of a bent member, especially in connection with the treatment of arched ribs.

Just what is meant specifically by the "new principle" is not obviously clear. The use of analytic expressions for the work performed in stressing both beams and pieces subject to direct stresses of tension or compression in the determination of deflections and for other similar purposes, is quite old. It would also seem to be much more simple to write the author's Equation (4) in correct form, by a direct equation between the external work performed and the sum of the two expressions for work, one covering members subject to direct tension or compression, and the other covering those subject to bending. This would render superfluous and eliminate the analytical work preceding Equation (4).

In passing, the surprising statement of the author, following his Equation (14), may be noticed. In referring to that equation, he writes, "which is the most general form of the Theorem of Three Moments." The most general form of the "Theorem of Three Moments", as is well known, provides for a variable moment inertia, a curved or broken center line of beam or truss, and other features which are not even recognized in Equation (14). In fact, that equation is really a highly restricted form of equation expressing the "Theorem of Three Moments."

Mr. Janni. A. C. JANNI,* M. AM. SOC. C. E. (by letter).†—It has been already remarked by others that the conception of the angular displacement, or rotation, of a cross-section of a solid body, as well as the derivation of the relative formula, is not new; indeed, it is as old as the conception of the linear displacement of a point of a solid body, together with its relative formula. The claim to novelty in this case, therefore, seems to be quite out of place. Any good textbook will give some method of deriving this formula from the general expression of the "virtual work", either by the theorem on the "derivative of work", or by invoking the principle of "least work."

Of course, in using this formula, any book of higher engineering does not need to explain fully its origin, for it is assumed that whoever consults such books, is already familiar with the theory by which this

* New York City.

† Received by the Secretary, August 27th, 1919.

formula has been worked out. That this is the logical assumption of the authors of these books is noted, for instance, in Grimm's book on Secondary Stresses, which is one of the only two mentioned by Professor Swain in his paper, as having been consulted by him on this matter, and which would justify his belief that the principle treated by him is new. In Chapter VII of this book, the author, speaking about the principle of "virtual work", states "with which the reader is supposed to be familiar." Mr. Janni.

That Professor Swain has been able to work out from this established formula a few plain cases of equations of equilibrium is not to be wondered at, for the derivation of the formula itself was worked out long ago from these equations, as any student in any engineering school should know.

After these considerations, there does not seem to be any necessity or use for the Profession to go into details and analyze the interpretation as given by Professor Swain to an already established principle and formula, for, at the present state of the science, this interpretation, at its best, would hardly be used by a modern engineer, for it is obsolete, as will be shown later by comparison.

Although the solution of this problem, considered by itself, has a doubtful practical value in most cases of equilibrium, still it will be demonstrated that by the theory of the "ellipse of elasticity", it is possible to obtain the desired solution in a manner, which leaves no doubt as to the superiority of modern methods over the old ones. A few remarks will precede the exposition of the method.

To any elastic body there corresponds a certain quantity, or coefficient, called "elastic weight", which is a function of its length, its cross-section, its moment of inertia, and of the modulus, E, of the material.* It will be shown, in each case, how this elastic weight is to be computed.

The "elastic center" is the center of gravity of the elastic weights of a given body. If the elastic weight of a certain elastic system is concentrated, or applied, at the elastic center of the body, and a force,

* The geometrical axis of a solid, usually, is not a straight line, and its cross-section is not constant. In this case, the solid is to be divided into parts, and the elastic weight of each part, or element, is to be computed separately, as will be shown later.

These elementary elastic weights are designated, usually, by the letter, w, with a numerical progressive index, and each is supposed to be applied at the center of gravity of its own element.

The elastic weight of the whole body is the summation of these elementary elastic weights.

Considering these w's as forces applied to the various centers of gravity, the position of the center of gravity of the entire system of forces, w's, may be determined.

This point is called the "elastic center", and the whole elastic weight is supposed to be applied at this center.

The position of this point, usually, is indicated by the letter, G, as is its value, so we have:

$$w_1 + w_2 + w_3 + \ldots + w_n = \Sigma_1^n w = G.$$

Mr. Janni.

P (Fig. 33), is acting on the free end of this system, the following mathematical truth can be demonstrated:

The angular rotation α, of the free end of the elastic body, with respect to its fixed end, is given by the force times the static moment of the elastic weight with respect to the line of action of the acting force. That is, if P (Fig. 33) is the force applied, G, the elastic center and its value as well, and d, the distance between the line of action of P and the point G at which the value, G, is applied, then:

$$\alpha = P \times G \times d.$$

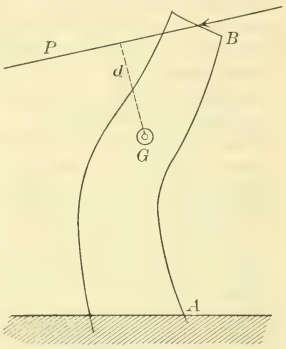

FIG. 33.

Consistent with brevity, a few cases will be shown, which will represent fairly the solution for most all possible cases in practice.

Attention is called to the brevity, uniformity, and directness of this method, as well as to the very elementary kind of operations involved, in order to obtain the result.

Case 1.—Let AB (Fig. 34) be the geometrical axis of a beam, fixed at one end, A, and free at B, and let P be a vertical force applied at B. The inclination, α, of the tangent at B' is desired.

Assuming that:

E = modulus of elasticity,
I = moment of inertia = constant, and,
A = area of cross-section = constant,

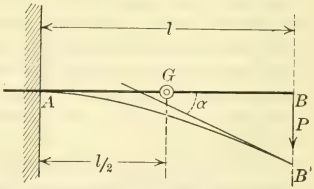

FIG. 34.

then the elastic weight of the whole beam is given by $G = \frac{l}{E\,I}$, and if it is supposed to be applied at G (the center of gravity of the elastic system), by the principle previously stated, we obtain:

$$\alpha = P \times \left(\frac{l}{E\,I} \times \frac{l}{2}\right) = \frac{P\,l^2}{2\,E\,I}$$

which result solves the problem.

Let us suppose now that the cross-section, A, is not constant, as is shown in Fig. 35; then, in order to take this variation into account, the

geometrical axis, AB, will be divided into a number of parts, such that each of them may be considered, without sensible error, as a prism. Mr. Janni.

Then, find the $\frac{\Delta l}{E I} = w$ for each of these parts and, assuming that each w is a vertical force applied correspondingly at 1, 2, 3, ..., determine the position of their center of gravity (elastic center), G.

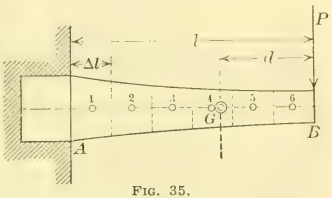

FIG. 35.

Now, remembering that the total elastic weight, G, is to be considered as applied at G, and remembering, also, the previously mentioned principle, we may write:

$$\alpha = P \times G \times d$$

where:

$$G = w_1 + w_2 + \ldots + w_6 = \Sigma^6_1 w$$

Case 2.—Angular Rotation of the Free End of a Three-Member Frame.—Let Fig. 36 represent a three-member frame, comprising a girder supported at its ends, A and B, by posts, CA and DB, the girder connections at A and B being rigid, the post, CA, rigidly fixed at C, and the post, DB, on rollers at D.

Let us assume, as is usual, that the system has no dead load, and let us remove the ground support at D. Assuming, also, that E is the modulus of elasticity, and I is constant for all three members, then the elastic weight for each post is given by $\frac{h}{E I}$, and that of the girder by $\frac{l}{E I}$; therefore, the total elastic weight of the system will be:

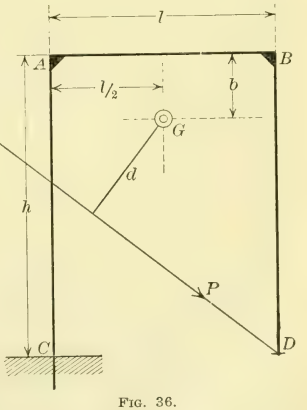

FIG. 36.

$$G = \frac{l}{E I} + 2\,\frac{h}{E I} = \frac{1}{E I}(l + 2\,h)$$

The elastic center, G, of the three elastic weights, each of which being applied at the middle point of the corresponding member (see the first problem of Case 1), for the cross-section, A, is supposed to be

Mr. Janni.

constant, will lie on the vertical axis of the symmetry of the frame, and at a distance, b, from AB, given by:

$$b = \frac{2 \frac{h}{E\,I} \times \frac{h}{2}}{\frac{1}{E\,I}(l + 2\,h)} = \frac{h^2}{l + 2\,h}$$

A force, P, applied at D, will cause a rotation of the section, D, which, by remembering the previously stated principle, is given by:

$$\alpha = P \times \left[\frac{1}{E\,I}(l + 2\,h) \times d\right] = \frac{P \cdot d}{E\,I}(l + 2\,h)$$

which is the result sought.

At this point, it seems to the writer that some remarks may be made, which are rather interesting.

Suppose that the force, P, revolves about D, then the angle, α, will vary with the distance, d. If, therefore, the line of action of P passes through G, then d is zero and, consequently, $\alpha = 0$. In this case, then, the section, D, does not perform any angular rotation.

In the previously mentioned theory, it is demonstrated that, in this case, Section D performs only a linear displacement, in a certain direction. The amount of this linear displacement and its direction can be determined, but it is not thought necessary to enter this field any further.

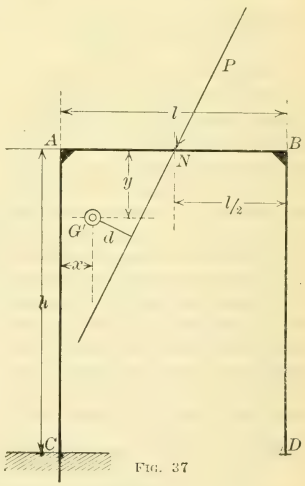

FIG. 37

Let us suppose that the force, P (Fig. 37) is not applied at the end D, but at some other point of the frame, say, at the middle point, N, of AB. Then this force, as far as internal stresses in the frame are concerned, has no effect on the half frame at the right of force, P, that is, on NBD.

In this case, we determine the following elastic weights:

$$\text{Elastic weight of } A\,C = \frac{h}{E\,I}$$

$$\text{" " " } A\,N = \frac{l}{2\,E\,I}$$

$$\text{Total elastic weight} = \frac{1}{E\,I}\left(h + \frac{l}{2}\right).$$

Mr. Janni.

The position of the center, G', is, evidently, given by:

$$x = \frac{\frac{l}{2EI} \times \frac{l}{2}}{\frac{h}{EI} + \frac{l}{2EI}} = \frac{l^2}{2(2h+l)}; \quad y = \frac{\frac{h}{EI} \times \frac{h}{2}}{\frac{h}{EI} + \frac{l}{2EI}} = \frac{h^2}{2h+l}$$

Therefore:

$$\alpha = P \times \left[\frac{1}{EI}\left(h + \frac{l}{2}\right) \times d\right] = \frac{P\,d}{EI}\left(h + \frac{l}{2}\right).$$

Here, also, if the line of action of P passes through G', the section, N, and, consequently, the end, D, of the frame does not perform any rotation, but only a linear displacement.

Incidentally, by inspecting Figs. 36 and 37, it may be seen that it is always possible to regulate the force, P, in each case, as to its intensity and line of action, so that the rotation, α, of Section D is the same in each case.

It can be seen also that by the use of this principle in the solution of problems of this kind, apart from the fact of the very elementary operations required, one gets also an absolute and easy control of the behavior of the elastic system.

Case 3.—Let AB (Fig. 38), represent an arched solid, the law of generation of which may be any, and let us suppose that it is fixed at B and free at A (the terminal section of the solid). The angular rotation of the end section, A, is required, in the hypothesis that a force, P, acts on the whole solid at A (this force may be imagined as acting on A, away from A, but rigidly connected with it). The solid is divided into any number of parts (seven in this case), and the corresponding seven elastic weights are computed.

Imagine that these elastic weights, $w_1 = \frac{\Delta\, l}{EI_1}, w_2 = \frac{\Delta\, l}{EI_2}, \ldots w_7 = \frac{\Delta\, l}{EI_7}$, are forces, each applied at the corresponding center of gravity 1, 2, 3, . . . 7 of the voussoir or element, and determine the position, G, of the elastic center (center of gravity of the elastic weights).

Then, if P is the acting force, the angular rotation, α, of A, by making $G = \Sigma_1^7 w = w_1 + w_2 + \ldots + w_7$ is given by:

$$\alpha = P \times (G \times d) = P \times G \times d.$$

which value solves the problem.

If P' is the force applied to the elastic body then, as in Case 2, the terminal section, A, will not perform any angular rotation, but a linear displacement, the amount and direction of which can be determined, as previously stated.

In the case in which the force applied is P_1, then, similarly, as in Case 2, the position of G' must be determined, as well as its value; remembering, however, that, in this case, the elastic weights to be

Mr Janni.

omitted are $w_1 = \frac{\Delta l}{E I_1}$ and $w_2 = \frac{\Delta l}{E I_2}$, for the force, P_1, has no direct effect on the two voussoirs, 1 and 2.

The position, G', the center of gravity of the system 3, 4, 5, 6, and 7, being determined, and the value of d_1 found, we will have:

$$\alpha = P_1 \times (G' \times d_1) = P_1 \times G' \times d_1$$

which solves the problem.

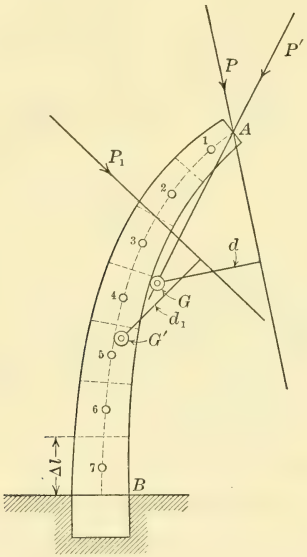

FIG. 38.

Case 4.—Finally, let AB (Fig. 39) be a latticed arch, having the end A fixed and the end B free. Let us find the angular rotation of B when a force acts on this elastic system.

In the solution of this problem, the most general method will be used.

If we put:

l = length of 1–3,
r = distance between Point 2 and Line 1–3,
E = modulus of elasticity, and,
A = cross-section area of Member 1–3,

Mr. Janni.

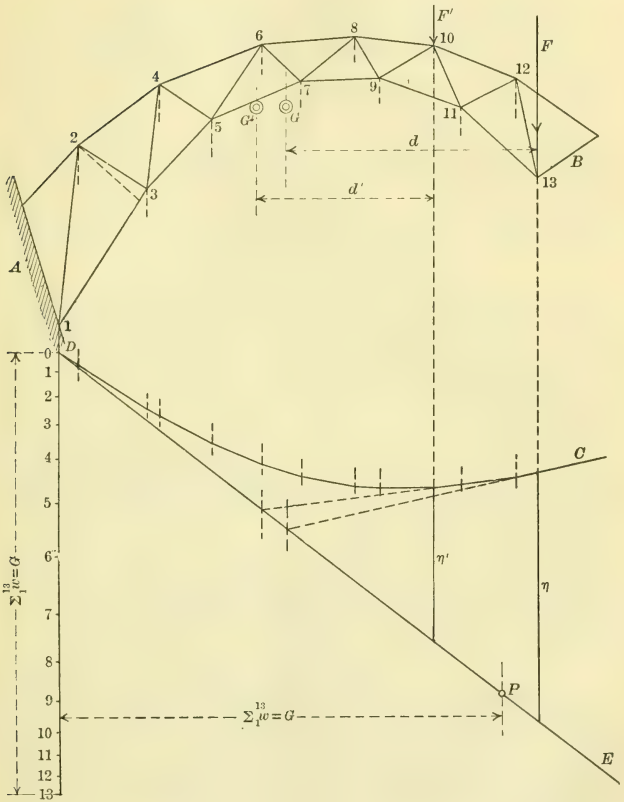

FIG. 39.

Mr. Janni. then, the elastic weight corresponding to the Member 1–3, by the theory of the ellipse of elasticity, is given by:

$$w_2 = \frac{l}{E\ A\ r^2}$$

which is supposed to be applied at its corresponding pole, 2.

In the same way, the other elastic weights of the system, w_1, w_3, ... w_{13}, may be computed and applied to the corresponding poles, 1, 3, ... 13.

Now, draw a vertical line and lay off on it, at a convenient scale, all these elastic weights.

Choose any pole, P, at a distance from this vertical line equal to $\Sigma_1^{13} w = G$, and on the verticals passing through 1, 2, ... 13, construct the corresponding funicular polygon, CDE.

Let us suppose now that a vertical force, F, is acting at B on the whole system, then, as has been previously stated, the rotation performed by Section B is to be computed by the formula:

$$\alpha = F \times (G \times d) = F \times G \times d$$

If, η, is the intercept on the vertical line of F, determined by the polygon, CDE, then:

$$G \times d = \eta \times (\Sigma_1^{13} w = G)$$

therefore, we may write:

$$\alpha = F \times G \times \eta \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

which solves the problem.

Let us suppose, now, that the force F' is acting on this system, then omitting the elastic weights, w_{11}, w_{12}, w_{13}, on which the force, F', has no direct bearing, the new system will have a new elastic center, G', and its value will be $G' = \Sigma_1^{10} w$.

Identically, as before, we will have:

$$\alpha = F' \times (G' \times d') = F' \times G' \times d'$$

and, if η' is the intercept, as shown in Fig. 39, then:

$$G' \times d' = \eta' \times (\Sigma_1^{13} w = G) = \eta' \times G$$

therefore:

$$\alpha = F' \times G \times \eta' \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

By inspecting Equations (1) and (2), it may be seen that there is no necessity, in any case, to determine the position of the elastic center, but that the construction of the polygon, CDE, is sufficient for the solution of the problem, no matter what the point is on which the external force is supposed to act. That is, we may write the expression, α, in its most general form, thus:

α = Acting force $\times$ Total elastic weight $\times$ Intercept on the vertical of the acting force by the funicular polygon, CDE.

This kind of a problem, could hardly be more elegantly and simply solved than by the use of this modern theory.

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THE EAST CANYON CREEK DAM

Discussion*

By Herbert E. Bellamy, M. Am. Soc. C. E.

Mr. Bellamy.

Herbert E. Bellamy,† M. Am. Soc. C. E. (by letter).‡—This paper is of the greatest interest to the writer, particularly the two points describing (1) the contraction joints, and (2) the fine clayey sand used with the concrete. It must be gratifying to the author to know that the structure is a pronounced success. In the present age, engineers all the world over are so in the habit of reading of successful works accomplished, that it is a very rare thing, indeed, to hear of a defective or faulty one. However, it is the writer's intention to refer to a dam recently constructed, which is not entirely successful, due principally to (1) faulty contraction joints, and (2) faulty sand used in the concrete. The dam in question is known as the Ridgeway Storage Dam, and is used in connection with the city water supply of Hobart, Tasmania. This dam was completed in January, 1918, and was filled to top water level in September, 1918. Figs. 7 and 8, respectively, show the plan and elevation of the dam, and the reduced levels marked thereon are, in all cases, the heights above sea level. Fig. 9 is a view of the face of the dam from the east side.

The following are the principal dimensions of the wall:

Dimensions of Dam:

Top length of west wing	293	ft.	7 in.
" " " arch	232	"	9 "
" " " east wing	203	"	6 "

* Discussion of the paper by A. F. Parker, M. Am. Soc. C. E., continued from August, 1919, *Proceedings*.

† Hobart, Tasmania.

‡ Received by the Secretary, August 5th, 1919.

Mr. Bellamy.

Maximum Depths:

Top of arch to foundation.....	201 ft.
" " " " bottom of shaft.....	285 "
" " " " east of reservoir....	100 "
East wing, maximum depth.....	105 "
West wing, maximum depth.....	103 "

Thickness:

For whole length of wall.....	8 ft. at top
" " " " "	6 " below coping
Arch at bottom.....	46 ft. 6 in.
East wing at bottom.....	64 ft.
West wing at bottom.....	58 "

Dimensions of the Reservoir:

Area of water when full.....	19.3 acres
Distance round edge of water.....	64 chains (4 224 ft.)
Maximum depth of water.....	95 ft.
Capacity	207 000 000 gal.

The wall consists of two gravity wings with an arch between them. The wings and arch are not connected. The wall is of concrete, in varying proportions, composed of diabase (which was found on the site) and crushed sandstone. The arch is reinforced with rails, vertically and horizontally, and a reinforcement of four rails is run from end to end of the dam near the top.

The outlet works consist of a concrete tunnel more than 1 000 ft. long, and a valve tower, 108 ft. high, which is approached by a small, three-span, reinforced concrete bridge.

Between the wings and the arch of the dam wall, a 6 by 6-in. bitumen joint with sheet lead faces was carried from the ground level to a distance of 2 ft. from the top of the wall, with the object of forming a water-tight key, as shown in Fig. 11. This method, however, was absolutely ineffective, and leakages took place through these joints as the reservoir was being filled. When a depth of 30 ft. of water in the reservoir was reached, there was a great leakage through the radial joint at the junction of the arch with the eastern gravity wall, but this stopped entirely as soon as the water level had reached a height of 40 ft. No further leakage has taken place through this joint.

Regarding the joint at the junction of the arch with the western gravity wall, a leakage took place as soon as there was 30 ft. of water in the dam, and this continued to increase in intensity until the reservoir was filled to top water level 905, that is, a depth of 95 ft. The estimated quantity of water leaking through this joint was no less than 250 000 gal. per day. As this leakage was considered to be excessive, and

Mr. Bellamy.

FIG. 7.

Mr. Bradley.

HIDGEWAY RESERVOIR DAM
LONGITUDINAL SECTION
FIG. 3.
R.L. 910.00
T.W.L. 905.00
285'7" West Wing
Arch
292'9"
East Wing 300'4"
Spillway
Spillway
R.L. 715.00
R.L. 688.00

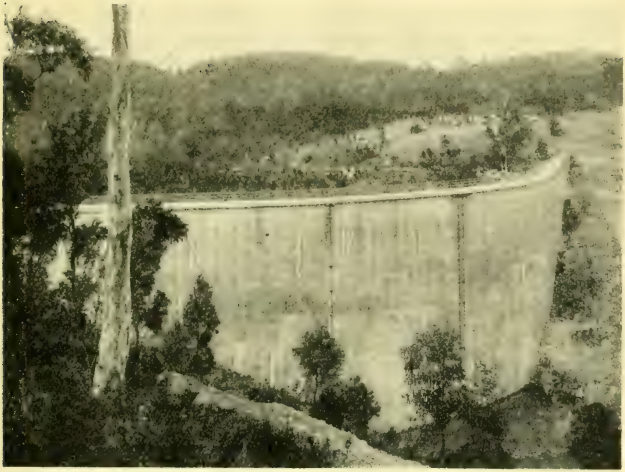

FIG. 9.—FACE OF RIDGEWAY DAM FROM EAST SIDE.

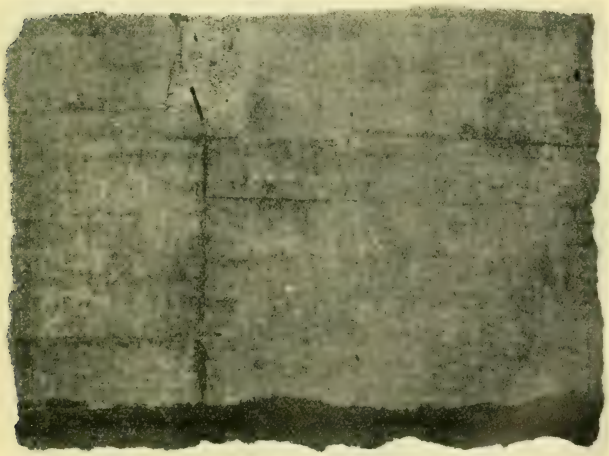

FIG. 10.—PARTING JOINT, WESTERN SIDE, RIDGEWAY DAM.

there was apparently no hope of it taking up, the writer recommended grouting the dam under pressure, but this advice was not adopted. Mr. Bellamy.

Reverting to the valve tower: It was found that water commenced to leak through the wall in several places when a depth of 30 ft. was reached in the reservoir, and the leakage continued right up the wall, increasing in volume until the top water level was reached. This leakage was considered to be even more serious than that through the dam wall, and was estimated to be 300 000 gal. per day. As this leakage could not be allowed to continue, the writer recommended that the reservoir be emptied, and that an entirely new internal lining, of especial concrete, 6 in. thick, be placed from the bottom to the top of the tower. This work has now been completed with entirely satisfactory results. While the reservoir was being emptied in order to effect the necessary repairs to the valve tower, very careful examinations were made by the writer of the dam wall on the up-stream side. It was found that almost the whole area of the concrete face of the wall for a depth of some 6 in. had softened and could be easily broken off. Particular attention was paid to the concrete at the parting joint on the western side. When the water level was 40 ft. from the top of the dam wall, the photograph shown in Fig. 10 was taken from a boat and indicates very clearly the parting joint on the western side. The concrete at the lower horizontal crack was absolutely rotten for some 2 ft. into the wall, and it was at this point that the major leak had occurred. In order to remedy the defects, the writer had a chase cut into the wall for the full depth downward, about 18 in. wide by 12 in. deep, and this was filled with especially made concrete. In addition, he proposes to render the whole face of the dam under pressure with the cement gun.

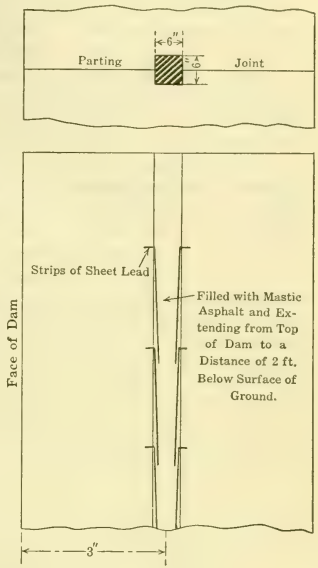
6″
Parting
Joint
Strips of Sheet Lead
Filled with Mastic Asphalt and Extending from Top of Dam to a Distance of 2 ft. Below Surface of Ground.
Face of Dam
3″

FIG. 11.

The question now leads one to consider the reason for the softening of the concrete. All the cement used throughout the works was of first-

Mr. Bellamy.

class quality and had passed all tests. The stone used was all that could be desired, but when the writer tested the disintegrated concrete, there was present a very large percentage of magnesium salts. The sand used in the concrete for the dam was obtained from a quarry almost adjoining the dam. This sandstone was taken from a small faulted block which had been carried up by the intruded greenstone, or diabase, a sill of which crowns the surrounding hills and in a hollow of which the reservoir has been constructed. A stratum of shale passes right through the sandstone which has been metamorphosed by the surrounding diabase and become impregnated by extraneous salts from the overlying decomposing rock. The writer also found several varieties of sandstone in the quarry. Analysis of the sand showed a large percentage of magnesium salts. Hence, the whole matter can be well explained as to why the concrete on the face of the wall and in the valve tower was unsatisfactory. The remedial measures which have thus been necessitated by the use of bad sand should serve to prove the absolute necessity of most thorough and searching investigations into all classes of sand likely to be used for structures; also, that short-time tests of sand and cement briquettes are not to be depended on.

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PAPERS AND DISCUSSIONS

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SEWAGE AND WASTES DISPOSAL FOR THE UNITED STATES ARMY

Discussion*

BY MESSRS. EDMUND B. BESSELIEVRE AND GEORGE T. HAMMOND.

Mr. Besselievre.

EDMUND B. BESSELIEVRE,† ASSOC. M. AM. SOC. C. E. (by letter).‡— The subject-matter of this paper is of great interest to the writer as he has specialized in sewage treatment, and, therefore, it possesses a peculiar claim on his attention. He also had the opportunity of being associated with the author, during the last year of the war, in the solution of sanitary problems at the various camps and cantonments of the United States Army.

The salient points of the paper which appeal to the writer, and which it is his intention to discuss, are the striking variations in composition between ordinary municipal sewages and those of the camps; the conditions entering into the selection and development of a proper type of tank for treating this sewage; the need for careful design of tanks and auxiliary units; and the need for careful operation of the tanks and co-operation between the designer and the operator.

The writer feels that the author has covered, clearly and satisfactorily, the question of reasons for adopting the single-story tank instead of the type which had been most commonly used by nearly all civilian engineers previous to the war. It is only fair to state here that previous to the writer's association with the Construction Division, he felt, as did the majority of sanitary experts, that the two-story, or Imhoff, tank was productive of the best results for all municipal sewage problems. However, a careful consideration of the subject and a thorough understanding, gained by personal investigation and observa-

* Discussion of the paper by Leonard S. Doten, M. Am. Soc. C. E., continued from August, 1919, *Proceedings*.

† Camp Travis, Tex.

‡ Received by the Secretary, August 18th, 1919.

Mr. Besselievre.

tion at various camps and the study of reports of results, etc., has changed this opinion to a great extent.

The conditions peculiar to the production of camp sewage were so different from those of ordinary municipal work that, considering these conditions and the need for speedy construction and economy in cost, it was seen that a single-story tank with some modifications from the older types of the septic tank would be the most reasonable one to adopt.

The life and habits of the soldier are regulated by strict discipline, producing a great tendency toward unusual concentration, at certain short periods, of the usage of sanitary facilities. This established a peak load in the sewers higher in all cases than in those of any municipality of which the writer could find record; and, also, due to the controlled usage of water, produced a high concentration of the sewage itself. Owing to the congested housing conditions and comparatively short length of run to the point of tankage, the result was a fresh, practically uncomminuted sewage, with a high suspended organic solid content.

Naturally, in comparison with a sewage traveling a relatively long distance and one that is more dilute and, due to length of flow, highly comminuted and partly septic, the first mentioned, or camp, sewage would require, regardless of any consideration of the composition of the diluting water, a tankage of greater duration in order to allow of proper and sufficient deposition of suspended and settleable solids during the passage through, and greater provision for the retention and digestion of the resultant deposit. These were the basic principles of the tanks designed and built by the Construction Division, under the author's direction.

The writer was greatly astonished when, during a study of the constituents of municipal sewages and those of various camps, the tremendously high suspended organic solid content of the camp sewages was made apparent, and the data on page 239* of the paper, showing averages only, do not indicate the maximum; but with an average of 750 parts per million of suspended organic solids, it can be easily assumed that the maximum was considerably higher.

As this average is so much greater than that for any municipal sewage of which the writer has had reports, it does not require, in his opinion, any further arguments to show the necessity, to any sanitary engineer, for a tank different from the usual municipal type, disregarding for the moment the considerations of speed of construction, cost, and the temporary character of the camps.

In either camp or municipal practice mere excellence of design does not necessarily guarantee satisfactory results. To the writer fully 90% of the production of a satisfactory, unoffensive tank effluent

* *Proceedings*, Am. Soc. C. E., May, 1919.

depends on the intelligent operation of the unit, based on the recommendations of the designer and a thorough understanding of the principles involved in each particular design. Mr. Besselievre.

Unfortunately, in quite a few cases, the tanks built by the Construction Division, despite all precautions and recommendations, did not have the co-operation of operator and designer and, due to this, there were several instances where, in two places, similar tanks working with sewage of like character gave results nearly diametrically opposite.

During the past 13 years, the writer has visited professionally a majority of the sewage treatment plants in the United States, and observations at these places have strongly embedded the conviction that the principal cause of failure in the production of satisfactory results is due to faulty operation.

Excellent design, embodying careful consideration of all conditions, has been negatived in several cases by the lack of intelligent operation or intentional neglect, due either to want of interest or knowledge on the part of the municipal authorities, or to the natural stupidity or laziness of the operator who has been selected in all probability for political reasons rather than for his ability to operate the plant as intended. On the other hand, plants improperly designed were, nevertheless, due to careful and intelligent operation, capable of producing the results intended at the time of design.

Despite the military discipline at the army camps, it was not possible, in all cases, to obtain the degree of control desired by the engineers of the Construction Division. Lack of knowledge of the principles involved in the design or proper operation, coupled with the sad fact that the average layman considers, usually erroneously, that a sewage disposal plant is a disagreeable place in which to work, and the supposition that intentionally faulty operation would secure release from such a detail, may have been the causes contributing to the trouble in the few cases in which it arose.

The writer is a strong advocate, in all cases where sewage treatment plants are built, of having it distinctly a part of the engineer's contract that not only is he to design and supervise the construction of the plant, but he is to have the selection of the attendant and be responsible for his proper instruction. He should make periodical inspection trips to the plant for a certain specified time in order to ascertain whether all instructions are being carried out and the desired results obtained.

In the field of plant operation and control, the State of New Jersey has undoubtedly taken a long step forward by the passage of a license law for operators of sewage disposal plants. This law provides for intelligent operation, and the unique Sewage Works Association of New Jersey has been one of strongest advocates of such legislation and has done more than any other organization to bring it about and thereby place New Jersey as a pioneer in this phase of engineering, the

Mr. Besselievre.

intelligent operation of public utilities. It would be well if other States followed her example in this regard.

In the determination of the retardent action of grease on proper septic tank action and sludge digestion and the formation of non-soluble scums, a long step forward was taken by the adoption of proper grease-retaining traps, either at some point near the septic tank or, as in the later work, by separate traps at each kitchen or group of kitchens. The results obtained in the operation of tanks and filters after the removal of the grease content, have more than justified the opinion of the detrimental action of grease, and their cost has been a minor item compared with the beneficial results and the reclamation value of the grease obtained from these traps before its pollution by sewage.

Instances have been known where a tank which had been operating indifferently before the removal of the grease, would show entirely different and eminently more satisfactory results, after it had been thoroughly cleaned and the grease traps introduced. In view of the results obtained, the writer feels that, for the sake of obtaining better and more rapid sludge digestion, freedom from scum, and the protection of sprinkling filters, some form of grease-retaining device should be introduced, regardless of the reclamation value of the grease obtained.

It is, of course, manifestly impracticable in municipal work to introduce a grease trap in each house, as this would make necessary the construction of some central grease-retention device. This would eliminate any reclamation value of the grease, as it would be polluted by sewage and, therefore, worthless, but the increase in efficiency of the tank would more than offset the slight additional expense of the trap.

In one case with which the writer is familiar, namely, a camp in the District of Columbia, the average weekly total accumulation of grease removed from the traps in the camp, which was a small one, was 2 000 lb.; and after a small soap-making plant had been set up, the authorities were able to make sufficient soap from this grease to supply all the kitchens and laundries in the camp.

In line with the author's call for further research and development work with a view to the procurement of more satisfactory plants, the writer desires to elaborate on several features of design, which, not having been given the necessary study, have caused trouble in a number of municipal plants inspected by him.

In referring to the design of units of a sewage treatment plant, the writer wishes to call attention to a particular feature in connection with the design of dosing tanks for sprinkling filters, which has been brought strongly to his attention by visits to more than 150 municipal plants in the United States and the observation of their failure to function properly due to lack of proper attention to this detail.

Mr. Besselievre.

Although the dosing tank is a small unit of a sewage treatment plant, and is, the writer fears, one that is usually passed over hurriedly in design, it is, nevertheless, one of the most important units, and unless proper and intelligent design is made, an otherwise well designed plant can be made very inefficient.

If the dosing tank is not properly proportioned to the volume of flow to be handled, the filter may be improperly dosed and a negative result secured in the filter effluent.

Regardless of the length of the dosing period, the capacity of the tank, its shape, and general features of construction, the method of connection to the filter distribution piping should be given careful attention and study.

The size of the tank should be proportioned to the dosing period and the inflow, so that the volume discharged during the total discharge period will not be excessive during abnormal flows. Therefore, a careful selection of the dosing apparatus should be made so as to provide for the drawing down and "breaking" of the siphon action at the predetermined low-water line, regardless of the rate of inflow.

The writer has seen numerous municipal plants wherein this point has not been carefully considered and, due to insufficient siphon size or nozzle capacity, the siphon at times of maximum flow would go into continuous operation, with the consequent flooding of the filter for periods of hours. This results in canalization of the effluent through the filter material and the production of negative results as to purification of the effluent. A careful study of this point, with a proper use of the data provided by the manufacturers of siphons and nozzles, will tend to eliminate the trouble which may be caused very easily by neglect of this particular feature.

Another important feature in the design of a sewage treatment plant, and one which although not exactly in the dosing tank, nevertheless applies to it, is the consideration of the means of connection between the siphon mouth and the distribution system of the filter. Neglect of the importance of this point and improper design has caused, to the writer's knowledge, the failure of several municipal plants.

Failure to design this connecting link properly has resulted usually in the loss of the most valuable head in the dosing tank, namely, the first few inches or first foot. Such loss is due to laying the pipe connecting the siphon mouth with the distribution system above the level of the nozzle orifices so that after each discharge of the siphon this piping was drained and at the next discharge, sufficient liquid was required to fill this empty piping before the water would appear at the nozzles. This was sufficient to reduce the head in the dosing tank to such an extent that the radius of nozzle spray, in turn, was reduced to a few feet from the nozzle, leaving the filter with a very large percentage of unwetted area.

Mr. Besselievre.

The effect of such a small radius spray is an overdosing of the portion of the filter immediately adjacent to each nozzle and tendency to canalization of the liquid through the filter without proper bacterial action.

In one particular municipal plant, with which the writer is familiar, the loss occasioned by this feature was such that with a dosing tank having a draft of 24 in., the loss of head, due to improper layout of piping, was 10 in., and the resultant radius of spray was about 4 to 5 ft., whereas the design of the plant was based on a radius of 11 to 12 ft.

In all cases, the discharge piping after leaving the siphon mouth should be dropped at once to such a level that the top of the pipe will be below the elevation of the lowest nozzle on the filter bed. It is impossible, of course, to get all the piping below the nozzle orifice, but with the drop beginning immediately after the vent connection at the siphon mouth, the minimum amount of piping will be emptied; the volume of this piping may then be ascertained and allowance made in the design of the tank so that the first inch or two from the top will contain sufficient liquid to fill this empty piping without the loss of the most valuable head of all, the initial head.

This consideration of the layout of the piping between the siphon and the filter is all the more important when a long period of dosing is used, with a corresponding long period of filling, during which period the piping is draining. With a short dosing period and a short filling period, the draining period is of necessity also shortened, and the emptying of the pipe lessened, so that the harm in this case is reduced; but, nevertheless, regardless of the length of the dosing period, this point should be carefully considered.

In closing, the writer desires to state that he believes that the type of tank and plants described by the author, for conditions similar to those found in army camps, when properly operated in accordance with the ideas and opinions of the designer, have given eminently satisfactory results.

Mr. Hammond.

GEORGE T. HAMMOND,* M. AM. SOC. C. E. (by letter).†—This paper should prove of much interest to the Engineering Profession. It suggests the way to simpler methods of sewage and wastes disposal, and to further research work along certain practical lines. It also gives an interesting insight into some of the sanitary problems which had to be solved, under much stress and haste, by the engineers of the United States Army.

During 1918, and the first part of 1919, the writer was afforded an excellent opportunity to study, at first hand, some of the structures and methods which are described in this paper. He was not only able to make numerous visits to many of the cantonments and camps, but,

* Brooklyn, N. Y.

† Received by the Secretary, September 4th, 1919.

Mr. Hammond.

in the course of his duties as an engineer, he was called on to design and erect several similar structures, and to observe their operation.

During the period previously mentioned, the writer was in the service of the United States Government, at first as Sewage Disposal Expert and Sanitary Engineer to the United States Shipping Board, Emergency Fleet Corporation, on the staff of Morris Knowles, M. Am. Soc. C. E., Chief Engineer, Passenger Transportation and Housing Department, and had charge of the preparation of standard specifications for, and reports on, the sewage disposal of the industrial housing projects, as well as the review of plans for such structures. In many instances, these projects were large towns, some of which contained more than 2 000 houses. Like the cantonments, they had to be built in the utmost haste, and some of the problems met were quite similar, though on a smaller scale. Similar questions in sewage disposal arose, and, in several instances, the Doten plans for disposal plants and for grease traps were adopted. As Consulting Engineer, the writer has recently been in touch with these plants and is able to state that they are giving satisfactory service.

Following his service with the Housing Department, the writer was assigned to the staff of Lt.-Col. P. S. Doane, U. S. A., Director of Health and Sanitation of the U. S. Shipping Board, and was placed in charge, as Sanitary Engineer and Health Officer, of District No. 2, extending from Providence, R. I., to Camden, N. J., and containing thirty-five shipyards. Later, this department was by order of President Wilson, transferred to the U. S. Public Health Service, Assistant Surgeon-Gen. L. L. Lumsden succeeding Lt.-Col. Doane, as Director, under whom the writer continued to serve. While thus engaged, he had to provide a number of structures very similar to those described in this paper.

The writer came to regard the sanitary problems involved from much the same standpoint as the author, and to follow about the same methods in their solution, especially as certain designs and structures adopted under emergency conditions had proved, with properly regulated service, to be more successful than was expected and could be constructed quickly and cheaply.

The sanitary requirements met in the shipyards, and in the housing projects connected with them, arose mainly from the great number of men suddenly brought together in places where all utilities were absent, until provided, for housing or feeding them, or otherwise caring for them. The shipyards sprang up like mushrooms wherever a ship could be built and launched, often at places quite distant from cities; and the progress of these yards was quite wonderful. Where a few hundred men were at work one day, thousands might be working within a week; probably more than 500 000 men were engaged at one time in shipbuilding.

Mr. Hammond.

In the shipyards of District No. 2, there was at one time an aggregate of more than 100 000 men. In several yards, there were more than 10 000 men each, and in one more than 15 000. Dormitories, mess halls, restaurants, and other houses had to be erected, with the attendant sanitary arrangements, and water supply, sewers, and sewage disposal facilities had to be provided in haste.

The paper discloses only a meager outline of the difficulties overcome by the War Department, in that hurried rush to put our military house in order. Much might be said about it. Those who saw this effort under way will never forget what a tremendous achievement it was, or how well the organization created for this great service succeeded in its work. Yet, it is also true that the undertaking was even more vast than was realized by those engaged in it. We should never again permit our country to be caught in such an unprepared condition. The results achieved in getting ready our army, our ordnance, and our ships, seem scarcely less than marvelous. The credit for this result, so important to our country and to civilization, belongs, in a large measure, to American civil engineers who went at once to the assistance of the Government.

It was the writer's privilege to visit the sanitary utilities at many of the cantonments, and he believes that, making due allowances for the uncertain factors which the problems presented to the engineers who designed them, they were remarkably successful. There was, however, at least one mischance to regret. Many of these structures were not large enough for the service which became necessary soon after they were installed. The rapidity and volume of mobilization in the camps was not fully anticipated, and the factors of safety in the capacity of the sanitary structures were small. Water supply, sewage disposal, and some of the other camp utilities, were not designed on a liberal scale, and it happened, sometimes, that where provision had been made to serve not more than 25 000 men, a service for 50 000 was necessary within a few weeks of the date of completion.

The writer in his various visits did not at any time see these utilities of too large a size, and, frequently, they were not large enough to meet the requirements. It was so easy to send men to a camp by the trainload and make extra accommodations, if necessary, for them, and so difficult to extend the water supply and the sewage disposal plants, that it was not surprising to find the latter overloaded and put out of service by this unexpected burden. Under these conditions, the quantity of sewage probably did not increase as much as might have been expected, in proportion to the enlarged population, or as much as the quantity of suspensa which it carried, and especially the quantity of fats.

The sewage being treated by the disposal plants was the strongest the writer has ever seen, and it was very fresh, causing the tanks to clog rapidly with scum and fail to function as treatment units, unless the

scum was removed frequently, such removal in some cases being required daily. Mr. Hammond.

It was unfortunate, in view of this experience, that a larger provision was not made in the design of these utilities for increases in camp population beyond the first estimates. In all the sanitary structures, a liberal policy in expenditure would have been justified, as the health and comfort of the men in training was of the greatest moment, and the extra cost required to provide for contingencies would have been only a small proportion of the total cost of the camps.

In providing sewage disposal plants for the housing projects of the United States Shipping Board, Emergency Fleet Corporation, account was taken of the probability, or at least possibility, that the villages would be occupied long after the end of their emergency use; that they would afford permanent homes for families; and, in many cases, would be absorbed into neighboring cities and towns. The utilities, therefore, were put in with this in mind, but with all possible economy. Wherever the sewage could be led to existing plants, this was done. If conditions were proper, the disposal of sewage was by dilution; but there were several places where tank treatment was absolutely required, and the choice lay between septic tanks, Imhoff tanks, and Doten tanks. For these villages, the septic tank was considered improper, and, after much discussion, the Imhoff tank was rejected as not advisable. Granting their well-known excellent points, it was decided that Imhoff tanks should not be erected if the plant was to be within smelling distance of the dwellings, especially when treating such fresh sewage, as would be the case at these villages.

Under the most favorable conditions, the Imhoff tank is the most costly of all types to build, as well as the most costly and difficult to operate successfully. It requires from six months to a year to ripen thoroughly and is never free from the danger of "frothing" and creating a nuisance. When these tanks give trouble, they are worse than useless, and that they frequently do give trouble, periodical literature abundantly shows. For very fresh sewage with much grease, the writer considers them inadvisable. Small installations are especially likely to give trouble. In all cases, the plants at these villages would have to be near houses occupied for residence purposes. Nevertheless, in one instance, an Imhoff tank already built was used, and did not make its kind any more popular by its performance. In another instance, a city of considerable size joined with the industrial city in building a battery of Imhoff tanks, the writer, at the request of Admiral Bowles, acting for the Shipping Board, with the consulting engineer employed by the city and for the project, in selecting the design. This plant is not yet completed. It was located, however, so that complaints are not anticipated on account of odors; should odors arise—and the plant is large enough to expect that—they will be given proper care.

Mr. Hammond.

The "Doten" tank had been adopted for the military cantonments, and many such tanks were already in service. One was erected at Camp Meade, where it was operated under the Constructing Quartermaster, who, at the time, happened to be Maj. E. B. Whitman, M. Am. Soc. C. E., a former associate of the writer on the Baltimore Sewage Commission. The writer visited Maj. Whitman and was able to make a study of the tanks, which, designed for about 25 000 men, had clogged and failed to function under the load of about 50 000. One learns most about a tank by seeing it act badly; we all learn by such failures. What the writer learned by observing the Camp Meade tanks in distress, convinced him that the type had some good points; at least, it would not froth and boil over like the Imhoff tank under similar conditions, and it did not smell unless disturbed.

It was after several visits to Camp Meade that the writer became acquainted with the author, who kindly gave the officials of the Shipping Board many data concerning the design and characteristics of the Doten tank.

The first impression of this tank was certainly discouraging; but a long experience in sewage experimentation suggested the idea that it was doing better than should be expected under the conditions as seen. Arrangements were effected whereby the writer was enabled to visit and study a number of these tanks in service at the various cantonment camps, among which were the following: Fort Myer, Camp Meade, Camp Holabird, Camp Dix, Camp Mills, Camp Merritt, Camp Upton, and several others.

The first visits made to these camps were in June and July, 1918, at a time when, in every instance, from two to three times the load designed for was being carried by the tanks, which were generally being blamed for failure to function by those who did not stop to reflect that any tank has a limit of capacity, beyond which it will fail. The writer felt convinced that, if treated fairly, they would not be failures. Indeed, he was much surprised with the manner in which these tanks carried the observed overload. The sewage was of extraordinary strength, coming from men only, highly fed, with a large proportion of meats. The sewage was not only very strong, but it carried a heavy grease content and a vast quantity of fresh scum-forming materials. Under the conditions observed, these tanks filled with scum, cemented together with grease, which could only be got rid of by removal from the top. The sludge was removed without trouble from the hopper bottoms by the sludge pipes, and was dried with only slight, if any, odors on the drying beds. The heavy scum, however, which would not sink, of course, did not get down deep enough to reach the sludge pipes.

The scum trouble was caused mainly by the grease; when this formed about the floating solids, they rose to the top. The mass of

Mr. Hammond.

scum became a solid cake, which, on being removed, required burial in trenches in order to prevent a nuisance. To meet this difficulty, Maj. Doten introduced the grease trap described in his paper.

After observing the cantonment camp sewage and other conditions, the writer came to the conclusion that an Imhoff tank would have clogged and failed sooner under this excessive and abnormal service, and that, of the two types, the Imhoff tank probably would have caused a greater nuisance and would have been the more difficult to clean, as it would have become filled with fresh settled matter, below and above, and covered with fats long before digestion could have been established. It would never have had a fair chance to function properly. Indeed, in most cases, before a two-story tank could have been built and given time to ripen, so as to work normally, it would have been useless, as the war would have been over.

In the housing projects of the Shipping Board much fresh sewage, not unlike the cantonment sewage, was to be expected from restaurants, etc.; and it was believed that the Doten tank would give as good, if not better, service than the Imhoff tank.

It is probable that a self-cleansing fine screen, placed ahead of either of these tanks, would have made a great difference. With such a help, perhaps an Imhoff tank would have worked successfully, and the capacity of either tank might have been more than doubled. In some places, if not in most, a fine screen would have afforded sufficient treatment without the aid of tanks; but the grease problem would have given the apparatus much difficulty until it was overcome.

One of the most interesting items included in the paper is the tank or trap used by the author to overcome the grease difficulty. The grease carried by the sewage, as already stated, was remarkably great in volume. Numerous determinations of this include an average of 150 parts per million for all the plants.

The writer was informed of instances at various cantonments in which more than double this quantity had been noted. This is about ten times the usual quantity found in ordinary domestic sewage, and its effect was to fill up the disposal tanks with floating solids embedded in a grease cake. With this condition, no tank could function properly. Unlike ordinary floating solids, the grease was carried past the baffles and over weirs, so that it spread from the inlet to the outlet compartments of such plants as that at Camp Meade. Moreover, it passed through a cycle of changes which caused an acid condition in the tank, and bad odors when it was cleaned. Grease trouble was encountered at all the plants visited by the writer late in June and early in July, 1918, and he was enabled to see some of these plants in the process of being cleaned.

The grease traps adopted at first were formed of a chamber about 18 in. in diameter and 30 in. deep. As about four cans of very hot

Mr. Hammond.

dish-water had to be discharged from each kitchen, after each meal, each as large as the "trap" it had to pass through, such a trap was useless. To meet this difficulty, the grease catcher or trap described by the author, was designed and built with good effect. After its construction, the work of the disposal plants was quite another story. Even though the tanks were heavily overloaded, the grease trouble practically disappeared, and, with it, to a great extent, the excessive scum formation. Moreover, the recovered grease was fairly clean, and sold for a good price. Many of these grease catchers were used on the writer's recommendation by the U. S. Shipping Board, not only in the industrial villages, where cafeterias and eating houses were provided with them, but, also, in connection with the restaurants and eating places in the larger shipyards.

No form of sewage treatment tank known to the writer would have operated successfully with this grease coming into it, least of all an Imhoff tank which would have had its flowing chamber clogged very quickly, and would have been in an acid condition throughout. It probably would have frothed and boiled over continually, causing active nuisance from sickening smells. It never would have produced "ripe" sludge. For sewage of the peculiar character and strength produced at the cantonments, after careful study of these plants, and by comparing them and the results obtained with other designs, the writer is convinced that the type selected was fortunate for the purpose. He agrees with the author that it is probably a fact that mutiple-compartment tanks are more capable than any other form for protecting trickling filters and sand beds from grease carried in the sewage; but he also thinks that no form of tank will accomplish this object with entire success, unless an efficient grease catcher, or trap, is used as near as possible to the camp, or retaurant, kitchens, so as to take out the grease at the head of the line. By this method, 95% of grease can be recovered on the average, and sold at a profit; and if this is done, other forms of tanks might have a fair chance of success.

When operating within their capacity, under proper control, the author has shown that the Doten tanks effected a high degree of sedimentation. Even when grossly overloaded with sewage of unusual strength, the effluent was usually well clarified. The removal of more than 90% of settleable matter from a sewage carrying 464 parts per million of organic solids, is certainly an excellent result.

When these tanks were first designed, there were probably few data on which to determine their size, even for ordinary municipal sewage, and it is very improbable that any one could have foreseen the character of the sewage they would be required to treat. The writer does not know of any digestion tank that will treat successfully the character of scum formed in these tanks, if saturated throughout with heavy grease which preserves the organic contents to a remarkable

degree from digestion agencies. Such scum was, in its keeping qualities, not unlike the "pemmican" used by travelers and Arctic explorers. Solids would not settle while associated with this grease, so there was small chance either of digestion or sedimentation; even silt adhered to this floating mass. Mr. Hammond.

The question may well be asked, To what extent may tanks of this form be expected to digest sludge? This is not easy to answer. That digestion of sludge and solids takes place in them to a greater or less extent, and under very unfavorable conditions, was evident to the writer in his examination of them. Leonard Metcalf, M. Am. Soc. C. E., has been quoted in a recent publication as saying that of those engineers who passed on the design of these tanks originally, only Maj. Doten believed that they would act as digestion tanks. Mr. Metcalf attributes the difficulty in the functioning of these tanks "to the fact that they were operated as digestion tanks". He says that the other engineers felt that they should be regarded essentially as sedimentation tanks, and, if so operated, they would do the work of clarification, and that was all that was thought necessary in the majority of cases. As clarifiers of sewage, there is no doubt of their success. The writer, however, does not think that the failures to function, which he saw, were due to their operation as digestion tanks. He has formed the conclusion that the cause of the trouble was overloading as sedimentation tanks. Up to the time when trouble occurred, the tanks operated in their own way without intelligent care, neither as sedimentation nor as digestion tanks, without regard to their capacity for either purpose, and without the removal of the scum until they were clogged. With the great volume of sewage pouring into them, carrying from 150 to 200 parts per million of grease; with 464 parts per million of fresh, settleable, suspended, organic solids entering at a rate of double and even triple their designed capacity, they were only about able to act as grit and scum catchers. Under these circumstances, there was far more flotation of suspended solids than sedimentation. They simply filled with grease and scum from end to end, as at Camp Meade, having merely a "convoluted passage" through them when thus filled, through which the sewage passed at a high velocity to the outlet. The fact is, a tank designed for 25 000 men will not serve 50 000 men with success, even as a settling tank. No digestion was to be expected from tanks operated in this manner, and yet some did occur. In the Fort Myer plant, when it was working within its capacity, the digestion seemed to be very good, and a fairly ripe sludge was produced, which dried quickly on a bed, without odors. Since the plants at the various camps have been relieved of their great overload, and have been operated within their capacity, the writer is informed that good digestive activity is being shown at many places, and ripe sludge comparable with the best Imhoff sludge is being produced. This is the best answer

Mr. Hammond.

to the question as to digestion. It would be interesting to give this, as well as the other features presented by these tanks, a more thorough experimental study. They have turned out in service much better than the writer would have expected, and show some advantages over other forms of tanks which, at least, makes them very interesting.

The Housing Department of the U. S. Shipping Board adopted a design of plant using these tanks, in which multiple units of full size were placed parallel with each other, the purpose being to keep one unit at a time in service on the daily sewage flow, until it had collected enough sludge and scum to interfere with its function as a sedimentation tank. It was then to be put out of active service and given a rest period, long enough to obtain complete digestion of the contents, when it would be discharged, the ripe sludge being dried on beds. Meanwhile, another unit would be in active service. In one plant, four such units were provided in a battery, and placed under the cover of one building. As a rule, at least two units were provided. How successfully this plan may work out, cannot be foretold, as the service has not been long enough in either of the plants to prove anything. So far, they are working very well. The first one to be put into its rest and digestion period has only recently been taken out of active service.

It has seemed to the writer that these tanks, which were designed for sedimentation and clarification of sewage, were not so well fitted for the digestion of sludge, and could not be depended on for this purpose. His reason for this is perhaps rather theoretical and derived from studies, made at the Brooklyn Experiment Station, on Imhoff tanks and separate digestion tanks, in which the results seemed to indicate that a complete separation of the sludge under digestion, from the flowing sewage, was desirable; and a minimum capacity, of 2 cu. ft. per capita below the slot lines, was necessary in the digestion chamber. This applies to Imhoff tanks treating domestic sewage, such tanks being not less than 24 ft. deep from the water line to the sludge outlet.

In the other tanks, however, conditions differ from the Imhoff tank. The series of compartments, baffles, weirs, etc., have a selective action on the settleable solids, and the finer the organic particles, the quicker may digestion be accomplished. There is no such assortment of sizes in the Imhoff tank, in which the sludge is not ripe until the most resistant of the larger solids in it ripen. It may be true, therefore, that Imhoff tank digestion requires more time and more space than would be the case in the middle and outlet compartments of the Doten tank.

On the other hand, it seems doubtful whether the scum and settled matters in the first compartment of the Doten tank will digest in any reasonable time, because of their size and resistance to bacterial action, even when the tank is out of service and at rest. No digestive

Mr. Hammond.

action is to be expected in this compartment while it is in active service; but if the grease in the scum does not prevent such action, hydrolysis and solution take place, and the dissolved materials are carried over with the flow of sewage to the next compartment, where it appears that digestion occurs rapidly.

Thus, it seems possible that if a tank of this type can be designed so that the first compartment is made of just the proper size for the flotation and hydrolysis of scum, which will not accumulate more rapidly than it can be dissolved and hydrolized, with the second and third compartments designed so as to afford a proper capacity for digestion, it might prove a very important acquisition to the sanitary engineer. The outlet compartment appears to have a marked effect in reducing the finely divided and dispersed organic colloids, giving a high degree of clarification. This is especially marked where there are more than three compartments in the unit.

Among the Doten tanks in operation examined by the writer, possibly the most successful was that at Fort Myer, near Washington, D. C. This tank was working at about its designed capacity and was producing a good and well-clarified effluent and an excellent quality of sludge, which was odorless and dried readily on a sludge bed. The effluent was discharged through a dosing chamber on a trickling filter bed of the character and design referred to by the author, as follows:

"The filter has an undulating floor, the distributor pipes being placed on the summits and pipe-covered gutters in the depressions. Thus, the expensive system of under-drains, which is usually an important feature in plants for municipalities, was eliminated."

The medium depth averaged 5 ft., and the size of stone from $\frac{3}{4}$ in. to $2\frac{1}{2}$ in. The effluent was stable after 20 days, which is certainly a good result. Although the result of this design was good, and the cost low, the writer's experience and observation rather lead him to favor the standard design of placing the under-drains for all but very small plants like this one, at a minimum depth of 6 ft. for the medium. The absence of sufficient under-drains might cause clogging of the bed with humus during an "unloading period" of the filter bed. The design adopted by Maj. Doten, however, has certainly given some good results, and is worthy of further study. If the cost of filter beds can be kept down by this method of under-draining, more filters will be constructed.

The time occupied in the closing cycle, in applying sewage to trickling filters, has been given much study by engineers. Continuous discharge on beds through fixed nozzles has not led to the best results. Plants using this method have never equalled the capacity per acre which has been secured by those designed for interrupted dosing, as obtained by intermittent applications, with dosing tank and siphon discharge, through sprinklers.

Mr. Hammond.

Experiments at Brooklyn gave the best results when the interval between doses was very short, but actual, and the dosing period was also short. A small siphon chamber proved to be the best. For this reason, the Brooklyn dosing chambers were reduced about 25% from the size first provided, thus increasing materially the permissible rate of sewage application per acre.

The limit of 2 000 000 gal. per acre, which the author thinks should not be exceeded, the writer believes to be low, and he would permit from 2 500 000 to 3 000 000 gal., with effective dosings of domestic sewage, on a bed 6 ft. deep. This figure depends greatly on the character of the sewage. He does not quite agree with the statement, as of general application to all conditions, that:

"The humus discharged from properly functioning trickling filters should not create an objectionable condition due to putrefaction. The putrescible character of the effluents from some deep trickling filters, and also the humus held in suspension, is due either to an inferior quality of tank effluent or to improper dosing."

The writer believes that the humus from all trickling filters is at times more or less putrescible. He has never seen an exception to this rule, and the reason for it, he thinks, has little to do with the tank or the dosing, unless this is very uneven or grossly improper. The main cause of it is the lower forms of life in the filter bed, such as worms, etc., which are frequently being discharged with the effluent and make up much of the so-called "humus"; the gelatinous casts that come away from the filter, which are often loosened by worms, are also putrescible, and when "unloading" takes place, as it usually does in the spring and summer, putrescibility of the suspensa in the effluent is one of its prominent features. Of course, it is admitted that improper dosing may possibly carry a stream of untreated sewage through the bed, or may cause unloading; also that highly septic sewage may affect the aerobic bacteria so as to start an unload; but, although these things are possible, they are infrequent. There is no doubt, however, that some of the best trickling filters in the world discharge a putrescible humus with their effluent. For this reason, secondary settling tanks are necessary, except in small plants, or where the discharge goes into a large body of water.

The writer thinks that the plan of Messrs. Metcalf and Eddy, introduced at Fitchburg, Mass., of pumping filter humus back to the Imhoff tanks, is an excellent provision, as he knows of no way in which this humus sludge can be dried on a bed without causing bad odors.

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WATER SUPPLY FOR THE CAMPS, CANTONMENTS, AND OTHER PROJECTS BUILT BY THE CONSTRUCTION DIVISION OF THE UNITED STATES ARMY

Discussion*

BY MESSRS. GEORGE W. FULLER, P. H. NORCROSS, CLARENCE GOLDSMITH, T. KENNARD THOMSON, W. P. MASON, J. WALDO SMITH, E. T. THURSTON, K. M. BOORMAN, WILLIAM J. BOUCHER, MORRIS KNOWLES, H. F. DUNHAM, GEORGE A. JOHNSON, F. R. HARRIS, and MAURICE R. SCHARFF.

Mr. Fuller.

GEORGE W. FULLER,† M. AM. SOC. C. E.—Great credit is due to Col. Maury for the very efficient way in which he handled the water supply projects in the army camps. It may seem, perhaps, at first sight, that the construction of water-works for these communities of some 40 000 people was a relatively simple matter, particularly when they are spoken of in a city like New York where such large water-works projects have been undertaken; but, when one takes into account the fact that more than 30 camps, having an aggregate capacity of more than a million people, were supplied with water in a little more than 3 months, it is really a very remarkable record.

A part of the success of supplying water to these army camps, carried out in the short time that it was, was due to the very level-headed consideration of these matters prevailing in the Washington office. That is to say, they did not try to do in Washington all that was to be done in the line of engineering. They got out only two or three pages of concise specifications as to fundamentals; they trusted

* This discussion (of the paper by Dabney H. Maury, M. Am. Soc. C. E., published in August, 1919, *Proceedings*, and presented at the meeting of April 2d, 1919), is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

† New York City.

Mr. Fuller.

the men in the field to adjust to local conditions; they were wise, in this respect, as well as in the local personnel selected and in the general oversight exercised to keep investments as small as practicable.

The speaker has seen a great many of the water-works enterprises of the Federal Government in the past two years, and knows that Col. Maury is entitled to much credit for the practical sense that he has exhibited at every turn.

Many of the engineers, at first, were inclined to try to introduce for the various branches of the military establishment schemes on the lines of metropolitan enterprises with which they were familiar, and which would provide more water than was actually needed; but Col. Maury was always at the helm, feeling his way along and heading off these large metropolitan water schemes that were not needed; and, at the same time, guarding against serious water shortage.

It is to be hoped that the methods which were established for handling these water supply projects will be recorded for the benefit of our military establishment for all time. Col. Maury also might have said quite a little about the operating steps taken to control the wastage, which was first sought to be effected by direct military order.

These details need not be recited here at great length; but, in addition to rigid inspection, many devices were introduced, such as putting marbles in the top of each header leading to showers and notching the end of the pipe on which the marble rests. The insertion of perforated metal blocks on top of headers was also used for reducing the quantity of water delivered to the large number of shower baths at the camps. There were about 15 000 fixtures in a single camp, and wastage in some of them might have interfered seriously with the continuity of the supply. One other interesting procedure for restricting waste was the very simple one of bending down the float in each flush tank in the lavatories, so that there was a smaller discharge from the tank. The main fact is that they got along comfortably with 50 gal. of water per capita daily, as originally specified. This is a very creditable record, and reflects the benefit of the adequate engineering direction of Col. Maury and his associates.

Mr. Norcross.

P. H. Norcross,* M. Am. Soc. C. E.—The speaker, who has been working continuously for the past 22 months for the Construction Division of the Army, first as Supervising Engineer on Cantonments, and later as an Assistant to Col. Maury, had the opportunity, soon after the work began, of becoming intimately acquainted with what Col. Maury was doing, and the general specifications and instructions for supervising engineers, pertaining to water supplies at the Government enterprises; for these reasons he feels qualified to offer a few remarks.

* Atlanta, Ga.

Mr. Norcross.

At the beginning, few, if any, of the supervising engineers concurred in Col. Maury's suggestion, that an allowance of 55 gal. per capita daily was ample for all needs and demands, as they had gained their experience in American municipalities, and quite naturally felt that, not only was this quantity of water inadequate, but that such a suggestion was almost heretical. However, they accepted this figure, and constructed water supplies in accordance with the general specifications prepared by Col. Maury's office. The wisdom of the plan soon proved that 55 gal. per capita daily was sufficient for all the needs of the camps, and the early difference of opinion has been supplanted with almost unanimous approval by the consulting engineers and the Military Establishment.

Mr. Fuller has mentioned the importance of preventing the adoption of "metropolitan" ideas in the construction of camp utilities. Col. Maury realized this necessity at the beginning, and very quickly succeeded in impressing on the supervising engineers the fact that "time was the essence", and that costly refinements of design and construction would cause serious delays and were not essential to the building of cantonment water supplies.

One of the greatest economic municipal crimes of the United States is the extravagant use of water. In no city is this emphasized more acutely than in Washington, D. C., where the daily consumption runs as high as from 150 to 160 gal. per capita, and where practically 60% of the total water furnished is used by Government departments, for which no direct charge is made. The remaining 40%, which is used by the private consumer, bears the entire burden.

Much has been said regarding the speed with which the Construction Division supplied the War Department with camps. Speed was even more important in the construction of the water utilities, because of the vital necessity of establishing both temporary and permanent water supplies before the construction forces, and subsequently troops, could be quartered at the cantonments. To civilians, accustomed to the slow and systematic method in which cities and other bodies politic construct their utilities, the short time within which the water supplies were made available can only be accounted for as the result of a species of patriotic zeal and endeavor, unprecedented in history. This, in a large measure, was attributable to the cordial co-operation and enthusiasm that Col. Maury imparted to those who came in contact with him. The speaker and his fellow-workers could not help but be impressed with the necessity for urgent and more urgent action. To use a military expression, the *esprit de corps* of the Construction Division, composed practically of civilian engineers from all sections of the United States, is something that no one can explain, but it is a tangible memory that all can recall with pride.

Mr. Norcross.

Wherever it was possible, water was obtained from existing developed supplies, owned either by municipalities or private corporations. As a member of Col. Maury's staff, the speaker had the opportunity of negotiating, both with municipalities and public service companies, for the purchase of this commodity, and feels that some comments on the policy adopted by the Advisory Engineer for Water Supply in these negotiations may be of interest: Many of the National Army and National Guard camps were situated near municipalities, ranging in size from 20 000 to 60 000 people; consequently, if water was purchased from an existing supply, the demand on that plant was practically doubled. To the Advisory Engineer of Water Supply was delegated the powers of negotiating these contracts. To consummate these with fairness and equity to the seller, and, at the same time, to obtain reasonable rates and service for the Government, required, in addition to technical ability, unusual diplomacy and tact. The records of Col. Maury's office will show that there prevailed a closer harmony and co-operation on the part of the seller and buyer than has ever previously existed in public service dealings in America.

In many instances, due to increasing, or doubling, the personnel at the camps, the municipalities, or corporations, had to make a great increase in their normal facilities for supplying water. When these cases arose, the Government financed and constructed the work, and allowed the city, or private corporation, to be reimbursed on a basis of 75% of the actual cost to the Government, payments being made in water service, and interest charges on obligations thus incurred being deferred until after the cessation of hostilities.

In conclusion, the speaker desires to say that Col. Maury has reflected great credit on the American Society of Civil Engineers, the Construction Division of the Army, and the Engineering Profession in general, by his able and fair-minded method of seasoning his technical work with the proper modicum of common sense and fair dealing.

Mr. Goldsmith.

CLARENCE GOLDSMITH,* M. AM. SOC. C. E.—Because of the unfamiliarity of most of the Supervising Engineers with the laying of wood stave pipe, the work presented certain problems which had to be overcome with a minimum of delay. In those parts of the country where wood stave pipe had been used, it was customary to provide special bells, on valves, fittings, and adapters, which were tapered to receive the tenons of the particular pipe being laid. The diameters of the tenons of the several sizes of pipe of the several manufacturers were not uniform, and in most cases the individual manufacturers had a few patterns of the ordinary fittings with bells designed to fit the tenons of their pipe. In some cases the inner surface of the bell was only snagged and smoothed with a file; in a few cases the inside of the

* New York City.

bell was machined. It is obvious that the machined bell made the better joint. Mr. Goldsmith.

More than 1 100 miles of wood stave pipe were laid by the Construction Division, and, therefore, it was impossible to secure special castings and machine them in order to provide for the bends, branches, and adapters required.

Owing to lack of experience, together with the haste with which the work had to be done, and the resultant makeshift methods used in many instances, it was feared that the underground leakage would be excessive. This, however, did not prove to be the case, for as soon as the Maintenance and Repair Division got the operation of the water systems under control, tests showed that the average leakage in the 20 or more miles of mains in each of the several camps was not more than 200 000 gal. per 24 hours, and, in one camp, it was found to be about 100 000 gal. This rate does not compare unfavorably with that ordinarily found in distribution systems laid with cast-iron pipe.

In order to assure the tightness of the system, it is absolutely necessary to leave the trench open, with only a small quantity of filling replaced over the pipe between the collars, to prevent the line from floating, in case the trench becomes filled with water, and to keep the pipe line filled with water under little or no pressure for several days, in order to allow the staves to swell. When the line is ready to be tested, a pressure of about 50 ft. in excess of the working pressure should be applied, and all leaks which are found should be stopped by inserting plugs or wedges. It is desirable to have at least one man who is experienced in laying wood pipe, in order to direct the work and repair any leaks.

In some cases considerable objection was raised to keeping the trenches open long enough to permit the test, but the necessity of making it more than counterbalanced the inconvenience involved. If leaks are not stopped before back-filling, the escaping jet of water frequently forms a sand-whirl which quickly cuts the wire and causes the complete failure of a section of pipe. In one case a sand-whirl cut completely through a 1-in. corporation cock.

Service connections to fir pipe (which has a thick stave) were made by inserting a corporation cock with a wood thread into a hole of slightly smaller diameter which had been bored with a bit. The thickness of the shell of the redwood pipe is insufficient to assure the holding power in all cases, and it is desirable to have saddles, with outlets of the desired sizes, wound on the pipe to receive the corporation cocks. The standards developed for service pipes provide for screwing the iron pipe directly to the corporation cock. It was not considered necessary to provide lead goosenecks, and experience has shown that they were not necessary. The saving of material and labor thus effected was considerable.

Mr. Goldsmith.

The speaker is of the opinion that, even if it had not been necessary to conserve cast iron and steel, the use of machine-wound wood stave was justified, both because of its lower cost and because it could be laid so quickly. Although machine-wound wood stave pipe cannot be considered as desirable beneath permanent pavement, in closely built-up sections, it is certain that it is adapted for use in a much larger field than has previously existed, particularly for force mains and in undeveloped sections.

Mr. Thomson.

T. Kennard Thomson,* M. Am. Soc. C. E.—The Society is much indebted to Col. Maury for this very valuable paper. The work done by the Army and Navy engineers has wakened the whole profession, and cannot fail to have a broadening effect on future engineers as well as those of the present.

The reference to placing the water and sewer pipes where they will always be exposed to view, makes the speaker hope that this practice will become much more general than it is at present. He remembers the time when it was impossible to reach the plumbing, in most cases, without doing great damage to the house, and, even now, it is impossible to reach water, gas, sewer, or other pipes without tearing up the street—an almost continuous operation. The sum paid for such work would be more than enough to pay for putting all such pipes in permanent tunnels, so that the streets would never have to be torn up, except to repair the roadway.

A few years ago a water main broke, over a subway that was being built, and started to flood an adjoining cellar. It took three hours to get the city to turn off the water, and the only way a catastrophe was avoided was by constructing a dam of sand bags and diverting the water into the sewers.

Quite recently, when some caissons were being constructed on lower Broadway, New York City, the water level rose 9 ft. above normal, just as the compressed air was put on the work. At first, the Water Department thought that the work had caused the water to rise, which, of course, could not be. The work was continued, and the water level dropped back almost 11 ft. Some of the new subways are below the water level, and may or may not be affecting it, but it seems to be certain that the water level in lower New York City cannot rise and fall from 9 to 11 ft. under old buildings, which rest on the so-called New York quicksand, without sooner or later wrecking some of these buildings. It might be stated here that the ground-water in lower New York City used to stand always from 6 to 9 ft. above the high-tide level.

The object of these remarks is to lead up to the hope that, in the future, proper tunnels will be constructed for all pipes and wires, and

* New York City.

that even the subways for cars will not be holes in the ground, but constructed so that there will be sidewalks and stores throughout their whole length, on both sides, and an opening, 2 or 3 ft. wide, in the center of the street, for the whole length of each block, so that the subways will always be attractive and well-ventilated, thereby greatly enhancing the value of the adjoining property and the health of the community. Mr. Thomson.

W. P. Mason,* M. Am. Soc. C. E.—The speaker is particularly interested in Col. Maury's reference to the use of chlorine, as he is a great believer in some form of emergency defense, so that, in the event of sudden need, the people can be protected against a threatened catastrophe. Mr. Mason.

He is also greatly interested in what was said in reference to the daily quantity of water supplied, and is impressed by the wisdom shown by the author in deciding that 50 gal. per capita would be sufficient. In every community there are many who insist that water should be "as free as air", and many believe that large quantities are needed to flush the sewers. If they would only call to mind the little dribble that runs along the bottom of a large sewer, except in the case of a heavy rainfall, they would realize how small is the chance for sewer flushing under normal circumstances.

There is no reason for taxing a man for his neighbor's use or misuse of water, any more than there is for taxing him for his neighbor's consumption of gas; but, in the northern part of New York State, it seems to be absolutely impossible, so far as the speaker can find out, to keep the people satisfied with 100 gal. per capita per day. Perhaps they will feel differently after July 1st. The speaker does not know what the future will bring forth, in the matter of educating the public, but, to his mind, 100 gal. per day is enough for the average mortal.

J. Waldo Smith,† M. Am. Soc. C. E.—The speaker, unfortunately, has not been very close to any of this great work which Col. Maury has been doing; but from what he knows about it, it seems that the War Department was singularly fortunate in securing the few men gathered together in Washington, men of very broad experience and excellent judgment, who laid down the skeleton of the foundation for this work. Mr. Smith.

Secondly, the Department was fortunate in the personnel which was developed to carry out this work, and afterward to take charge of its maintenance and operation. This was done at great personal sacrifice on the part of a great many of these men, in many instances, as the speaker knows; and it is perfectly true, as both Col. Maury and Mr. Fuller have stated, that, following general directions, they were left largely to their own devices to develop those plants and expedite the work.

* Troy, N. Y.

† New York City.

Mr. Smith.

Col. Maury mentioned the form of contract under which this work was carried out. The speaker agrees with him that that was the only form of contract to be adopted under the circumstances; but he does not agree with the statement, in an address* by Gen. Marshall at the Annual Meeting, in January, in which he advocated the continuance of this form in general contract work after the war, because, in the speaker's opinion, the general adoption of such a form in ordinary work would be absolutely demoralizing to the whole contracting fraternity and very much against their interest, and, eventually, would lead to favoritism and discrimination, as well as the elimination of the gambling element, which is one of the principal interests in contracting.

Besides, there would be no chance for the man of great inventive resources, who is full of expedients and develops new methods of doing work.

To the speaker's mind it would result in a great deterioration of the contracting organizations. He does not know Col. Maury's opinion on this subject, but he was very much surprised to hear Gen. Marshall put it forth as a desirable feature. Certainly, the work of this Construction Division, of which so much has been heard during the last month or two, seems to appear as the bright and shining light of all the activities of the Army. This work seems to have been excellently planned and carried out, even to the details of operation and maintenance.

Of course, difficulties were encountered, but it seems that most of them were anticipated and prepared for beforehand; and when they were encountered, very prompt and effective methods were taken to remedy them.

Mr. Thurston.

E. T. Thurston,† M. Am. Soc. C. E.—The speaker's experience with the water problem in military camps was as a consumer only. At Camp Devens, Mass., where his unit was mobilized, during the bitter cold winter of 1917-18, water was abundant, and every desirable facility was afforded for its application to the needs of the men, thanks to the energy and foresight described in Col. Maury's paper. In France, however, the situation was quite different. Not only was there a scarcity of water, but the systems were primitive, following French practice. Strict economy was the watchword everywhere, although in less degree at the headquarters camps than elsewhere. In the wash-houses, water was delivered into overhead wooden troughs, about 8 by 6 in. in size, fitted with small wooden spigots at intervals of 2 ft. or so, which would emit a very small stream of water into the waiting hands of the washer. Wash-basins were not used, and usually guards were present to prevent the waste of water. Drinking water was chlorinated

* *Proceedings*, Am. Soc. C. E., February, 1919, pp. 164–171.

† San Francisco, Cal.

in canvas bags from which it was drawn as required; the drinking of unchlorinated water was prohibited. Mr. Thurston.

Shower-bath houses, with water heaters, were provided, but in many cases were of little or no use on account of the water shortage. This was the case at all the camps at St. Nazaire, except the headquarters camp. On arriving with his company, the speaker was informed by the Adjutant that the bath-houses were not to be used on account of the shortage of water. Thus, thrown on our own devices, we overcame the difficulty and incidentally provided the necessary hot water for cleansing mess kits, by foraging some pipe and a barrel, constructing a water coil for the field stove, and carrying hot water in buckets to supply the wash-house tank. The men were withheld from their details in convenient detachments, so that each man had a warm bath once a week. This case serves as a fair illustration of the ingenuity and energy displayed by American troops in overcoming incidental obstacles that confronted them.

The record of achievement provided by Col. Maury's paper is noteworthy. There are many others in every branch of the Service lacking publicity, and, it is hoped that a comprehensive record of the achievements of reserve officers in connection with the war will be prepared by sympathetic and informed persons.

K. M. Boorman,* Assoc. M. Am. Soc. C. E.—The speaker, whose last duty overseas was with the Water Service of the Second Army, feels that Capt. Thurston has given an inadequate idea of the water supply work in France. The Water Supply Service of the American Expeditionary Force was under the charge of Col. F. F. Longley, M. Am. Soc. C. E., who, the speaker believes, is known in New York City as a water supply engineer of some prominence. This service grew up with the development of the A. E. F. Mr. Boorman.

During the first year, the water systems were usually built by the construction units locally engaged in building the camps and bases, as well as the general construction work for the camps. Of necessity, the supply varied with the size and importance of the camp, and those built entirely by the American army acquired better systems than those enlarged from old French camps using inadequate French systems as a basis. At the large aviation center at Romorantin, a field built on a new site by the Construction Division of the Air Service, water was supplied, a few months after the work was started, to all the buildings for drinking purposes and shower baths, through a modern system of piping from the Sauldre River.

On August 8th, 1918, the Water Supply Service was ordered to be organized, to be composed of "certain officers and certain engineer troops", to be a separate organization under the direction of the Chief

* New York City.

Mr. Boorman.

Engineer of the A. E. F. By October, when both the First and Second Armies, fully organized, were operating on their own fronts, the Water Service was working thoroughly and efficiently. The 26th Engineers, with units of Pioneer Infantry attached to do the common labor, were assigned for this work in the Army areas.

"Water points" were established at all practical places. A typical procedure was to pump water from streams (such as the Rupt de Mad River in the Toul Sector) to a concrete settling basin, and run it through sand filters to a clear-water basin from which it was pumped into the pipe lines. It was usually necessary to chlorinate the water at the filters. From these basins the water was pumped to storage reservoirs accessible to the water tank trains of wagons and motor trucks, which were also part of the Water Service.

In many cases water was pumped through 4 and 2-in. pipe lines directly to the batteries firing on the German lines. During the last month of the War, the detachment of Co. B, 26th Engineers, near Thiaucourt, in front of Metz, connected their own pipes to miles of German pipe lines laid in the area gained in the St. Mihiel drive. This German piping was of sheet-iron and spiral-wound, usually about 3 in. in diameter; the American was the usual screw-fitting iron pipe. The pipes were buried to a depth of 1 m., for protection against frost and shrapnel.

The speaker hopes that, on the return of Col. Longley and Maj. A. H. Pratt, M. Am. Soc. C. E., Chief Water Supply Officer of the Second Army, they can be induced to present a paper on the work of the Water Service in France, of which the instances cited are only a small part.

Mr. Boucher.

William J. Boucher,* Assoc. M. Am. Soc. C. E.—The Charleston Port Terminal, at Charleston, S. C., on the Cooper River, about 11 miles from the City Hall, is an exceedingly well-planned rail and water terminal, consisting of an Animal Embarkation Depot, an Ordnance Depot, and a Quartermaster Depot. The property, Fig. 14, is traversed by the main line of the Seaboard Air Line Railway, is contiguous to the main line of the Atlantic Coast Line Railroad, and is also served (through connection) by the Southern Railway.

The Cooper River is a broad stream with considerable current, and, by a moderate amount of dredging, a channel depth of 30 ft. has been obtained. The ground is generally level, its elevation varying from 5 to 25 ft. above sea level; the surface is sandy, and the drainage is very good. When acquired, the land was partly covered with pine forest and partly devoted to agriculture.

The Animal Embarkation Depot or Remount (Mule) Station is at the westerly end of the reservation, and has accommodation for

* Philadelphia, Pa.

MAP OF
CHARLESTON PORT TERMINAL
RIVER

Mr. Boucher.

several thousand mules or horses. The pens or corrals are composed of simple fences, about 5 ft. high, without roofs. Hay is fed to the animals from a rack in the interior. The corrals are of varying sizes, according to the uses for which they are intended, and are joined by lanes with suitable gates. There are, in addition, the necessary office buildings, barracks for the troops caring for the animals, blacksmith shop, warehouses, feed buildings, and (open) hay sheds. Manure is shipped away in cars.

The Ordnance Depot covers an area of approximately 1 sq. mile, and is bounded on all sides by standard-gauge tracks, which, in turn, are connected by several parallel tracks. On each of the tracks, *D*, *E*, *F*, and *G*, there are eleven smokeless powder magazines, or forty-four in all. These are 32 by 96 ft., of wood-frame construction, covered with corrugated asbestos siding and a roof composed of gypsum blocks, covered with prepared roofing, rendering them fire-proof from the outside. The several buildings are separated from each other approximately 400 ft., in all directions. On tracks, *I*, *J*, *K*, and *L*, there are twenty-seven standard magazines, each 50 by 220 ft. These have brick pilasters supporting the wood roof-trusses, hollow-tile walls, and gypsum roofs (built in place, similar to reinforced concrete). On Track *O* there are eight primer and fuse houses, each being 32 by 96 ft. These have hollow-tile walls, wood rafters, and gypsum block roofs. There are seventy-nine buildings, of these three types, for the storage of explosives. There are, in addition, several guard-houses for the use of troops patrolling the area, a garage and battery-charging station, and a commodious administration building.

For the use of the Quartermaster Department there were planned six warehouses, each 160 ft. wide and 1 200 ft. long, and two open sheds of the same size, but work on the latter was stopped at the time of the Armistice. The warehouses are of brick and hollow-tile wall construction, with wood posts supporting a wood roof, and are only one story in height. They are divided by fire-walls 100 ft. apart, making twelve rooms to a building. A complete sprinkler system is provided for these buildings. On each side of each warehouse there are railroad tracks and team or motor driveways. One of the buildings is two stories in height for about one-third of its length, and this second floor is used as the Administration Office for the officer in charge. The warehouses are parallel to each other and normal to the dock, which extends along the shore of the river; all the warehouses are joined by a long head-house, which, in turn, gives directly on the dock.

The dock, which is a marginal wharf, extends from the southerly side of the first warehouse, in a northeasterly direction (following the river bank) about 3 300 ft. It was originally planned to be of concrete piles with a reinforced concrete deck, but the plans were modified, and it has been constructed of creosoted piles with a timber deck.

Mr. Boucher.

A standard gauge track, running the entire length of the dock, connects at both ends with the tracks on shore. For handling freight between warehouses or to ships, storage-battery trucks have been provided. Each carries about a ton, and, in turn, can haul several loaded trailers. Along the front of the dock, for its entire length, wood sheathing has been driven, forming a bulkhead, behind which has been deposited the material pumped up by the dredges in deepening and widening the channel. In this manner a large area of marsh land, overflowed at high tide, has been reclaimed, and the fill serves as a protection for certain untreated piles which were driven, the teredo being very active in the Cooper River.

The water supply for Charleston is obtained from the upper reaches of Goose Creek, and impounded by a dam approximately 20 miles from the city. Because of the greatly increased demands for water since early in 1917, and on account of the very dry summer of 1918, the supply proved entirely inadequate for the needs of the Terminal, and plans for increasing it were made early. Two wells were sunk in the Remount area and one near the Quartermaster warehouses; these are from 441 to 535 ft. deep, and supply a very good water, slightly impregnated with sulphur. In addition to these wells, an arrangement was entered into with the City of Charleston for increasing its supply, with Government aid. A dam has been constructed across the head-waters of the Ashley River and a 24-in. conduit of wood staves has been laid along the Charleston-Summerville Highway, connecting with the supply pipes leading into the Terminal. The reservoir for the Terminal consists of five circular wood tanks, on concrete foundations, each having a capacity of 200 000 gal. These tanks are near the pumping station, and the water is distributed from the latter through cast-iron pipes varying from 16 to 6 in. in diameter, for drinking, sanitary, and fire purposes. Some 12-in. wood-stave pipe is used between the 24-in. main in the highway and the reservoir. There are eighty-nine hydrants distributed about the grounds. A 10-in. pipe runs along the entire length of the dock, the head-house has a 10-in. wrought-iron main, and the warehouses are protected by sprinklers, the supply for the latter being contained in a 200 000-gal. elevated steel tank near-by.

During construction, temporary mains, up to and including 3 in. in diameter, were laid through the Ordnance area for mixing concrete, and 1 and 2-in. pipes supplied water to the inhabitants of the temporary camp. All these pipes have been removed. Permanent barracks for the use of stevedores (troops or civilians) have been erected, and in separate buildings there are lavatories and toilet facilities, similar to those at the several cantonments. There has also been constructed a power-house and refrigerating plant, and a commodious

Mr. Boucher. fire-engine house, containing a new model, chemical, motor-driven engine.

The Terminal was constructed jointly by The Degnon Contracting Company and The Mason and Hanger Contracting Company, on a cost-plus-fee basis, under the direction of the Construction Division of the War Department.

Mr. Knowles. MORRIS KNOWLES,* M. AM. SOC. C. E.—The speaker has had the opportunity of reading a report by M. R. Scharff, Assoc. M. Am. Soc. C. E., on the water supply in the region of Brest, and is impressed with the accuracy of the statement relative to the materials and other facilities for water supply protection in France being far less adequate and complete than were those for similar work done in the United States. It must have been true that much of this work was carried on with insufficient quantities of absolutely essential materials.

The speaker cannot refrain from adding a word of commendation for the work of Col. Maury and his associates, or from expressing his gratification at having had the opportunity to serve in the Cantonment Construction Division water supply work under the direction of Col. Maury; and, in commending this work, he wishes to speak especially of the independence and foresight with which Col. Maury and his staff assumed the responsibility of fixing the limit of use of water to be allowed in design. All know how difficult it is, in municipal water supply work, to convince people that a limited quantity of water constitutes a reasonable supply, and to combat the old fallacy that water should be as free as air. There is no doubt that many felt, at the time of this decision, as the speaker did himself, that there was serious doubt whether a limitation of designs and installations to a basis of 50 or 55 gal. per capita per day could be successfully applied. It is clear that the success which justified this decision was due, in a large measure, to the restrictive measures inaugurated for preventing excessive use and for distributing the peak loads by planning hours of use for various purposes. It would be interesting if Col. Maury would enlarge on these restrictions in his paper, and on the difficulties encountered in enforcing them because of conflicting military orders by the commanding officers of troops. In the speaker's experience, considerable difficulty was encountered from this source, and, as a result, a shortage of water occurred during certain hours of the day for a large part of the time.

The method of supervising the work of which Mr. Fuller spoke was certainly admirable, in that it offered many helpful services while leaving to those at the different camps a large measure of discretion and responsibility. It was not always altogether easy, however, to confine this supervision within the limits of this conception. If time

* Pittsburgh, Pa.

had been available to discuss every question, close supervision and detailed review would undoubtedly have resulted in more perfect and generally satisfactory designs. Under the circumstances, however, when everything had to be done in haste, it was inevitable that such close supervision and detailed review should have been, in some cases, impossible, and, in other cases, the cause, either of delay, or of resultant designs, suggesting the presence of two different and incompletely harmonized conceptions of the situation. Mr. Knowles.

One of the most troublesome problems in connection with cantonment water supply was the provision of a temporary supply. In the beginning there was a tendency to commence work at different points, without consideration of the difficulty or impossibility of supplying water at these points from any reasonably near source. Similar difficulties were encountered with the construction camps, which grew very rapidly, and with the National Guard units which arrived on the ground early for the purpose of establishing guards and protecting property. Frequently these latter units were commanded by officers of limited military experience who would wish to select camp sites which were not well adapted for the supply of water and the disposal of wastes. One of the things that kept the supervising engineer busiest at the beginning of the work was the location of such units so as to utilize in the best way the natural resources, and especially the shallow underground water resources, of the site. In spite of every effort, it was often impossible to avoid supplying such camps by transporting water in carts.

Referring to Mr. Smith's remarks about contracts, the speaker is in agreement with all those with whom he has been associated on war time construction work in believing that the form of contract used was the only one that could have been successful under the circumstances. In the same way, it was necessary to have similar contracts for the housing developments which were constructed by various governmental agencies for the emergency. It does not follow, however, that such contracts are desirable for work of this character carried out under more nearly normal conditions—although the speaker believes that it is possible to draft contracts based on cost-plus-a-sliding-scale fee, which may be advantageous at all times. The Emergency Fleet Corporation, with which the speaker has recently been associated, is canceling many of its housing development contracts on the cost-plus basis and letting the work anew on the unit-price basis. Not only has this been the means of saving a great deal on overhead charges, but it is gratifying to know that prices are being secured on the unit-price basis much lower than cost would have been if the work had been continued on the cost-plus basis.

In conclusion the speaker desires to express his gratification at having had the opportunity of being connected with the cantonment

Mr. Knowles

work—a feeling which he is sure will grow as time goes on and as the troubles connected with the work are replaced in his memory by the more pressing ones of other work.

Mr. Dunham

H. F. Dunham,* M. Am. Soc. C. E. (by letter).†—An important item in this interesting paper is the allowance of 50 gal. per capita. Every superintendent and manager of water-works has estimated the reduction in waste if he could have his consumers placed under military discipline. All have some knowledge of the subject. Figures from the average city are misleading, because they are obtained by using the population as a factor, whereas many people may obtain supplies from deep wells or other sources. A correction would increase the per capita allowance, but the cantonment figures are definite. Although a few cities like Fall River, Mass., and Providence, R. I., could have been cited as object lessons, courage was necessary in order to estimate as low as 50 gal.

The reply to one question—which may not be a fair one—would be of great interest: With the experience thus far gained, would the author, on a similar demand for advice to the Government, recommend the same per capita allowance?

It would also be interesting to know to what extent the force-main capacities were determined by fire-protection needs, and whether extra high pressure at the pumps was used in order to provide for the domestic supply during such a short period as a fire might continue.

Mr. Johnson

George A. Johnson,‡ M. Am. Soc. C. E. (by letter).§—The highly important functions performed by Col. Maury in connection with the great work of the Construction Division of the Army, makes noteworthy his becoming modesty in describing his participation in the unparalleled achievements of the Division and the happy manner in which he shares his very creditable record with his associates. It appears to be pretty well recognized at this time that the Construction Division as a whole accomplished a feat unequaled in the building history of the world, and, in this performance, Col. Maury is clearly correct in the premise that there is ample credit and glory for all who had a hand in it.

The rank and file of the Division, in addition to the material work they accomplished, established still another record of quite a different, and perhaps of quite as noteworthy, a character. As paper advertisers of their Division they made a sorry record, and as seekers after the plaudits of the public, they were almost a total loss. Probably no such aggregation of "go-getters" and "do-it-nows" was ever before brought together, and the conspicuous absence of endeavors to secure personal

* New York City.

† Received by the Secretary April 11th, 1919.

‡ Col., Quartermaster Corps, U. S. A., Constr. Div., Washington, D. C.

§ Received by the Secretary, May 12th, 1919.

benefit from the work they were doing in the great emergency redounds to the credit of the organization as substantially proving that they were laboring unselfishly to serve their country first, last, and all the time. Mr. Johnson.

On reading Col. Maury's paper one may at first thought conclude that with such utterly unprecedented methods of providing water supply facilities in the camps and cantonments as were of necessity followed in 1917, inadequacies, inapplicable features of importance, and structural inferiorities would make the road of the operating man who came after the intensive builder, a rocky one indeed. The writer was that man, and when he, like Col. Maury, was wired into the service (not by the time-consuming telegraphic process applied in Col. Maury's case, but by the quick acting telephone), he contemplatively reviewed on the train the probable formidable array of difficulties to be overcome because of the very nature of the problem, and the obstacles to success which he might reasonably expect to encounter, due solely to the speed with which the various systems had been put together.

Before he was made Assistant to Col. C. D. Hartman, Officer in Charge of the Maintenance and Repair Division, the writer was in direct charge of the Water and Sewage Section thereof, and, as such, exercised supervisory control over the water supplies in about 400 military establishments. In the permanent establishments the population to be served increased materially, following the declaration of war, of course, and, in each case, provision for adequate and pure water supplies had to be made, in order to keep step with the requirements, and a little ahead of them. In the camps and cantonments, although the problem was one involving entirely new construction, two factors introducing important complications had to be faced and solved satisfactorily, namely, to get the systems functioning on time and to provide, so far as was humanly possible, for the fluctuating population.

It is remarkable at this date to review the events following September, 1917, when the first increments of the new army began to arrive at the camps. The water systems were made ready in time; the supply was sufficient and pure; and fire protection well cared for by ample water pressures. All the water systems had been designed on a basis of a certain fixed estimated number of troops and animals at each individual camp, and a factor of safety of 2.85 times the average demand allowed in order that peak load consumptions might be anticipated satisfactorily.

The rapidly fluctuating camp population was perhaps the most difficult problem for the operator to meet, and a matter which the designers of the water systems could not anticipate with precision. A notable case in this line was Camp Dix which was laid out in all its parts for a maximum population of less than 45 000. At 3 P. M., on

Mr. Johnson.

one day, the population was 44 000. At 10.00 A. M., the day following, it was 60 000. The population of a small city had been moved in over night. How many city water superintendents have ever had such a problem to meet? With the facilities provided by the designers and the exercise of considerable resourcefulness on the part of the Utilities Officer, however, every man was adequately supplied with water, and fire protection requirements were met.

The water systems at all the military establishments were equal to the demands made on them. Naturally, in some cases, additional storage had to be provided, more pumping capacity, and similar augmentations made in the original systems, but the outstanding fact is that, as a whole, these water systems, conceived over night as it were (a fact confirmed by Col. Maury's description of the work at Camp Lewis), built in a mere fraction of the time usually required for such work, and called on to function satisfactorily from the start, did what they were expected to do. It was little short of a miracle that they did.

At the close of 1918, the Maintenance and Repair Division of the Construction Division of the Army had charge of the operation and maintenance of the water supply, sewerage, electrical, heating, refrigeration, and fire-fighting plants and systems, and the maintenance of the buildings and roads, in 46 camps and cantonments, 51 hospitals, 66 border stations, 25 supply depots and terminals, and 271 regular military posts, and, for its uses during the fiscal year ending June 30th, 1919, funds to the amount of $62 400 000 were allotted. Its field force, concerned solely in such operation and maintenance work at these points, numbered 452 commissioned officers and 16 559 enlisted men. In the head office in Washington, there were 20 commissioned officers and 126 civilians at the close of 1918.

At each completed project, in charge of the operating force, there is an officer selected on his record in civil life in the management of public utilities, holding a position comparable to that of city manager, but with detailed responsibilities and duties far transcending those of such an official. Indeed, he is a composite of city manager, city engineer, fire marshal, street and building inspector, manager of municipal water-works and sewers, telephone and electric supply companies, and cold storage, besides being general all-around handy-man to whom everybody comes to get anything fixed.

The local field organization is military in its character, and was worked out with a view to obtaining the greatest efficiency and the best results with a minimum of personnel and expense. A major is usually placed in charge of this highly important work, and has as assistants a number of commissioned officers of lower rank. For operative and clerical assistants, there is a detachment of enlisted men, the number depending on the size of the project, but varying from 300 to 800 in various camps and cantonments.

Each utilities officer maintains in his office a "trouble department" —a desk over which passes every complaint of whatever nature and every request for repairs and replacements. In addition to the written communications received, the number of telephone calls in the trouble department at each camp averages several hundred per day. All the work is supervised, co-ordinated, and administered from the Washington office. Refinements and economies are constantly worked out, and their effect is always toward giving the greatest service with a minimum expenditure of public funds. The Maintenance and Repair Division of the Construction Division's office is really a huge service organization, operating for the benefit of more than a million persons in several hundred locations, and designated to supply them with every convenience and comfort incident to their existence as soldiers. Mr. Johnson.

Failure in the great task delegated to the Construction Division of the Army was freely predicted, but the seemingly impossible was done effectually and economically. No greater tribute can be paid to those whose ability, untiring energy, and unselfish devotion were directly responsible for the successful performance of the colossal task of building the camps and cantonments in which to train the new army, and the other facilities required to make ready its translation to French soil, than to say that they were not found wanting in the supreme undertaking to which the nation had dedicated itself. Not only this, they have managed uniformly the hundreds of military establishments built by them in a fashion calculated to inspire improvement in existing methods of doing work along more or less parallel lines in civil life.

F. R. Harris,* M. Am. Soc. C. E. (by letter).†—Although this paper necessarily is of such a brief and general character that what the writer is about to state can hardly be considered in the nature of a discussion of its technical details, nevertheless, he would like to add his praise to the high character of the work performed by the Construction Division of the Army, and especially to the very excellent results produced by Col. Maury, as Advisory Engineer in general charge of the water supply development in connection with the cantonments and other kindred work. It was certainly of the greatest benefit to the country that the services of such able experts as the author and others whom he has mentioned as having assisted him, were made available to the Government. Mr. Harris.

During the early part of the war, the strenuous efforts of the United States to expedite its military programme resulted in the concentration of work in various locations along the Atlantic seaboard. In some places this concentration resulted in congestion and over-

* Rear-Admiral, C. E. C., U. S. N., Norfolk, Va.

† Received by the Secretary, August 14th, 1919.

Mr. Harris.

crowding so that in the smaller communities what are known as public utilities were thoroughly incapable of meeting the demands of the military and civil population congregating around these centers. This was especially so in and around the Port of Norfolk (using the word "Norfolk" as a designation to embrace the Port of Hampton Roads). The Port of New York was being used to its greatest capacity. It was so greatly developed and had been built up so normally that it was not susceptible of great expansion. The port facilities which Hampton Roads offered, were naturally great, but undeveloped.

On the Newport News side, the War Department had undertaken the construction of general embarkation camps, animal embarkation camps, corrals, storehouses, hospitals, and various other necessary works. On the Norfolk side, it started a huge new Army Supply Base, took over the terminals of the Norfolk and Western Railway, and proceeded to develop and enlarge these for an Engineers' Material Embarkation Depot. At Pig Point, near the mouth of the Nansemond River, it planned a large Ordnance Embarkation Station; later, at Camp Abram Eustis, on the Newport News side, it constructed one of the largest of the artillery encampments and proving grounds.

The Navy Department had well under way the plans for enlarging and rebuilding the Norfolk Navy Yard, the construction at Sewall's Point, on Hampton Roads, of a Naval Operating Base, a great extension of the Naval Magazine, and, later, the construction, in the vicinity of Yorktown, of a Fleet Fuel Oil Reserve Depot and Ordnance Station. Directly to the north of this, the War Department, under contract with the du Ponts, planned a huge shell-loading plant at Penniman. The Navy Department and Shipping Board jointly undertook great extensions in the Newport News Shipbuilding Plant, and, incidentally, the various Departments interested took over for operation in connection with the Railroad Administration the large coaling plants of the Chesapeake and Ohio, Norfolk and Western, and Virginian Railroads.

All these construction activities starting at or about the same time, and entailing together a cost of approximately $200 000 000 taxed this community far beyond its capacity to furnish the requisite labor, house the labor furnished, and, considering the military personnel on the Newport News side, amounting usually to about 50 000, and the naval personnel on the Norfolk side, amounting probably to 20 000 men, resulted in practically a complete breakdown of all community utilities such as transportation, electric power and light, roads, water supply, etc.

In the earliest days of this problem, Col. Maury, acting for the Construction Division of the Army, attempted the task of expanding and extending the water supply in the vicinity of the Port of Embarka-

Mr. Harris.

tion at Newport News, and began to study the problem of the Norfolk water supply. Practically, single-handed, he obtained much information for future use and did much good on the Newport News side within the limited funds and authority at his disposal.

The conditions of congestion previously enumerated resulted in the inevitable. None of the work on the programme could be pushed, there were insufficient men, materials, and resources, to push all of them at once, and as there was no priority as to which should be done first and no organization to plan for systematizing the work, orders for which had been issued by several different Departments and Bureaus acting independently of one another, congestion, waste, and a most serious labor turn-over resulted. The two military Departments, War and Navy, finally attempted to correct the difficulties by appointing a representative of each Department to confer and agree on priorities, etc. Later, this was expanded into what was known as the Board of Control, War Construction Activities, in which the War and Navy Departments, the Department of Labor, U. S. Housing Corporation, U. S. Employment Service, Railroad Administration, Fuel Administration, Shipping Board, Emergency Fleet Corporation, and, later, the War Industries Board, were represented, of which Board the writer became President. The agreement as to the organization of this Board and its scope and authority was subscribed to by the Secretaries or heads of these various Departments, and an attempt was made through it to co-ordinate the efforts in the Hampton Roads District for the general good, with the idea of advancing the war construction programme. This Board soon gave its attention to the conditions of congestion and to the inadequacy of the utilities serving the port. Funds were secured through the instrumentality of the Chief Executive from the various Government Departments interested, and allotted to the performance and securing of adequate water supply, transportation, light and power, roads, etc. The writer then first became acquainted with Col. Maury, and was guided and advised by him relative to the needs for water supply extension in the District. Col. Maury also played a large part in the plans and programme finally decided on and approved for securing potable water to meet the demands of the Port of Norfolk.

In this preliminary work, it is only fair to state that the services of Maj. J. A. Bensel, Corps of Engineers, U. S. A., Past-President, Am. Soc. C. E., who had been assigned to the Board as an assistant, contributed largely and, in fact, first brought to the Board's attention the conditions with respect to the water supply and the absolute need of taking immediate steps to secure its extension and enlargement, as an alternative to seriously hampering the War Department's plans with respect to the use of the port for the embarkation of the assigned quota of military forces to be transported to France.

Mr. Harris.

Col. Maury impressed the writer at the conference at Washington so favorably with his thorough knowledge of local conditions, and his familiarity with what was needed, that, in the allocation of the improvement in water supply of the port, the writer advocated that this work be entrusted to the Construction Division of the Army, with the understanding that Col. Maury was to give it his general supervision. Under that arrangement Col. Maury took up the negotiations and planned the work for the extension of the Newport News water supply, thus practically trebling its original capacity, the extension of the Portsmouth water supply on about the same basis, and a co-ordination of the two separate water supplies of the City of Norfolk, with a view to placing them under one management. All this work, which is now completed, or rapidly nearing completion, although not carried out to its fullest extent on account of the end of the war, has involved an expenditure of upward of $5 000 000. Considering the limited time and the various other difficulties which the writer has not time to enumerate, but which are common to war construction activities undertaken in times of such great stress, the work has been well carried out to the great credit of Col. Maury and the organization which he represented.

The writer desires principally to state, as a matter of record, his appreciation of Col. Maury's zeal, untiring effort, and willingness, under the most adverse conditions, to carry out the very great public service that he performed.

Mr. Scharff.

Maurice R. Scharff,* Assoc. M. Am. Soc. C. E. (by letter).†—As one who worked, as far as water supply was concerned, under the supervision of Col. Maury in the stirring days of July to October, 1917, the writer desires to express his appreciation of having had the opportunity to take part in the fine work of the Cantonment Construction Division, and the pleasure with which he will always remember the helpful attitude of the Washington office. Perhaps its greatest helpfulness lay in the fact that the plan of operation, as described in the paper, was not always strictly enforced and that a large measure of freedom was left to the Supervising Engineers in planning and constructing the work, while the supervision of the Washington office was confined to the enforcement of general standards and to help in securing rapid deliveries of materials.

The conditions under which the writer served as Deputy in Charge for Morris Knowles Incorporated, Supervising Engineers at Camp McClellan, Anniston, Ala., illustrate very well the impossibility of submitting plans and reports to Washington and awaiting decisions and preparation of bills of material in the Washington office. When the writer arrived on the ground on July 16th, 1917, the site for the

* Pittsburgh, Pa.

† Received by the Secretary, September 2d, 1919.

Mr. Scharff.

camp was not yet selected, although arrangements had been completed by the local Chamber of Commerce for the purchase of a large tract of property which offered a number of possible locations for a divisional camp. Within the ensuing two weeks, the site was selected, the general plan of the camp outlined, railroad connections arranged for, and construction on the first unit started by the contractor. During the same time, a decision was reached to secure a water supply by connection to the mains of the water company supplying the City of Anniston, by the construction of a booster station and reinforcing and supply mains, 32 000 ft. in length. About August 1st, word was received that water must be made available in the camp for the troops who would commence to arrive on August 15th. The delivery and distribution of the pipe commenced the same day; pipe-laying started on August 4th; and although two days of rain intervened, on which no pipe was laid, the line was tied in and an ample supply of water for the first troops delivered to the camp by August 15th.

Some further facts about this water supply system are of possible interest, as illustrating the extent to which the design and construction were controlled by conditions other than those which would apply in ordinary practice. The source of supply of the water company supplying the City of Anniston is Coldwater Spring, a great spring gushing out of the limestone and said to have a flow of 25 000 000 gal. per day. Water taken from this spring is pumped to a distributing reservoir at such an elevation as to give a static head at the camp site of more than 50 lb. per sq. in. The largest size of pipe which there was any possibility of obtaining within the requisite time, however, was 10 in. in diameter, and this size was selected on the basis of possible deliveries, without regard for the fact that theoretical computations appeared to indicate that a larger size might have been more economical. With this size of pipe, it was estimated that at the assumed maximum daily rate of draft —1 500 000 gal.— a pressure of not less than 30 lb. per sq. in. could be maintained at the site selected for the location of a booster station, which would be sufficient to maintain domestic service to the sections of the city and suburbs dependent on this portion of the distribution system; and that by raising the pressure at the booster station to 130 lb. per sq. in., this quantity could be delivered to the camp with a resultant pressure at the camp site of 50 lb. per sq. in.

Another feature of the water-works system at Camp McClellan, which was controlled entirely by the time limit set for completion, was the location of the 10-in. supply main which followed, for the greater portion of its length, the existing tracks of the Southern Railway and the connecting line constructed for the service of the divisional camp. A location approximately 4 500 ft. shorter would have been available by following some of the existing country roads, but as

Mr. Scharff.

these roads were practically impassable for heavy traffic, it would have been impossible to complete the delivery of the pipe within the time limit fixed by military necessity.

The rapid delivery of the pipe required by this 32 000-ft. supply main and its completion and connection within 10 working days, must be ascribed largely to the authorization by the Washington office of the use of cast-iron pipe and to the co-operation of the Superintendent of the Anniston foundry of the United States Cast Iron Pipe and Foundry Company. This company furnished from its Anniston, Chattanooga, and Bessemer foundries all the pipe in the line, except about 5 000 ft. of Universal pipe, and when completed, the line contained in addition to the Universal pipe, standard bell and spigot pipe of Classes A, B, C and D; standard gas pipe of two weights; and several thousand feet of 9.8-in. (25-cm.) pipe of special quality, which had been cast for the Argentine Republic. Not only did the foundry superintendent devote a large part of his time in securing these deliveries, but, in addition, he arranged for the use of the foundry pipe crane, much of the time under his personal supervision, to distribute more than 20 000 ft. of pipe along the trench from the railroad, with maximum rapidity and minimum breakage.

The service of the Anniston foundry was also of the greatest value in securing the rapid delivery of special castings and even of flanged castings. On one occasion, while additional pumps were being constructed in the Coldwater pumping station of the water company, a crack was discovered on a Sunday afternoon in a 16 by 10-in. reducer. The superintendent of the foundry was reached on the telephone, and, on Monday morning, the completed casting, faced and drilled and still hot from the moulds, was delivered at the pumping station over 8 miles of country road. This service permitted the casting to be placed in position and pressure restored by 4 P. M. on Monday.

The early operations of the water-works system at Camp McClellan produced interesting examples of the difficulties, due to the peculiar character of water consumption in military encampments. The pressure from the city distributing reservoir was sufficient to deliver the quantity necessary for night use and the requirements of the first troops which arrived on August 15th, without booster pumping; but after the completion of the construction of the first booster pump, on August 19th, it was necessary to operate the booster pumping station throughout the day, every day, from about 5 A. M. to 7 or 8 P. M. This method of operation was sufficient to permit the continuous maintenance of satisfactory service after the completion of the camp distributing reservoir on October 13th; but, until that time, much difficulty was experienced in maintaining service, due to rapid fluctuations in pressure resulting from the large variations in hourly use. Prior to the completion of the reservoir, it was found to be impossible to

Mr. Scharff.

maintain pressure in the higher parts of the camps immediately after the noon mess hour, when the mess kits were being cleaned, and for the greater part of Wednesday and Saturday afternoons when there was no drill and when most of the showers in the camp would be found running either for bathing or washing purposes. These difficulties were especially great during the period from August 19th to September 11th, when the booster station was pumping into a closed system, not only without storage, but without adequate pressure relief. During this period, a direct telephone connection was maintained between the booster pumping station and the engineering office at the camp, and during certain portions of the day, an observer was stationed at each point watching the pressure gauges, the observer at the camp directing the operation of the suction valve on the pump so as to control the pressure at the camp. In spite of this precaution sudden pressure jumps occurred on several occasions, and breaks in the supply main resulted once or twice.

On September 11th, a pressure regulating stand-pipe of 10-in. pipe supported by a wooden scaffolding, was constructed and carried up to the elevation of the distributing reservoir (then under construction). At the top of this stand-pipe, an elbow and a 6-in. valve were leaded in, and this overflow at the highest point of the system proved a reasonably effective pressure regulator, although at times, some attention to the pressure gauge at the camp and control by regulation of the suction valves at the booster station were necessary.

In some respects, there was much similarity between the cantonment water supply work and that on which the writer was subsequently engaged in the Water Supply Division of the Office of the Director of Construction and Forestry of the American Expeditionary Forces in France. In both cases, the time element was of far greater importance than the ordinary considerations controlling engineering design. In one respect, however, the cantonment construction work was very much more satisfactory and enjoyable than that in France. Reference is made to the availability and orderly rapid delivery of material made possible by the efficient co-operation of the Washington office, as compared with the discouraging impossibility of securing materials, which resulted from the tonnage shortage during the early days of the history of the American Expeditionary Forces.

MEMOIRS OF DECEASED MEMBERS

NOTE.—Memoirs will be reproduced in the volumes of *Transactions*. Any information which will amplify the records as here printed, or correct any errors, should be forwarded to the Secretary prior to the final publication.

HERMON CHARLES ALLEN, M. Am. Soc. C. E.*

DIED MAY 4TH, 1919.

Hermon Charles Allen was born at Coloma, Parke County, Ind., on June 2d, 1870. His primary and high school education was acquired in the county of his birth, and his technical education at Purdue University, where he studied Civil Engineering for three years as a member of the Class of 1894.

In June, 1894, Mr. Allen entered the employ of Cook and Watkins, of Boston, Mass., as Chief Draftsman, which position he retained until January, 1896. From January to June, 1896, he was in charge of the construction of the city water and electric light plant at Gas City, Ind., under the direction of James B. Nelson, a Consulting Engineer of Indianapolis, Ind. After leaving Mr. Nelson, he was engaged from June to November, 1896, as Transitman on the Chicago Division of the Cleveland, Cincinnati, Chicago and St. Louis Railway Company (the "Big Four"), but left this position to accept another with the Illinois Central Railroad Company as Transitman and Assistant Engineer on preliminary surveys, location, and construction.

On the completion of this work, in October, 1897, Mr. Allen entered the employ of the Fort Dodge and Omaha Railroad Company as Resident Engineer on location and construction. He remained with this company until March, 1899, when he returned to the Cleveland, Chicago, Cincinnati, and St. Louis Railway Company, serving from March to July, 1899, as Assistant Engineer on Maintenance of Way, and from July, 1899, to November, 1901, as Supervisor of Track, on the St. Louis Division.

Mr. Allen resigned his position with the "Big Four" to enter the office of the City Engineer of Indianapolis, Ind., as Assistant City Engineer in charge of preliminary and final estimates, street grades, etc. He remained in Indianapolis until September, 1907, when he went West to accept the position of Assistant City Engineer of Great Falls, Mont. In March, 1908, he went to Glasgow, Mont., as City Engineer, where he designed and built the electric light and water systems and made a re-survey of the city, established street grades, etc.

In June, 1909, Mr. Allen returned to Great Falls, Mont., as City Engineer, and remained in that position until 1912, when he removed to Spokane, Wash., where he engaged in private practice as a Con-

* Memoir prepared by M. L. Morris, Esq., Great Falls, Mont

sulting Engineer, under the firm name of Tannatt and Allen. This firm handled a number of logging, mining, and irrigation propositions in Washington and Idaho, among which the most important were the irrigation of the Hercules Ranch and the betterments to the Day Brothers Mine, at Wallace, Idaho.

Mr. Allen was engaged in the mine work when, in 1918, he was appointed Chief Engineer for the State Highway Commission of Idaho, with headquarters in Boise, which position he held practically up to the time of his death, having just severed his connection with the Commission and entered the employ of Day and Rothrock. He died of heart failure, at Sprague, Wash., on May 4th, 1919, and is survived by his wife.

With his passing, the Profession loses a member of sterling worth and a man with stamina that was unsurpassed.

Mr. Allen was elected a Member of the American Society of Civil Engineers on May 2d, 1911.

HOLLAND WILLIAMS BAKER, M. Am. Soc. C. E.*

DIED FEBRUARY 18TH, 1919.

Holland Williams Baker, the son of the late Theodore Baker and Margaret Williams Baker, natives of Connecticut and New York State, respectively, was born on September 6th, 1851, at Norwalk, Ohio, where his parents then resided. In his eleventh year, the family moved to Cleveland, Ohio, where his father was engaged in the tannery business, and where the boy attended the public schools, though somewhat irregularly, as ill health during his youth forced him to do most of his studying at home.

Mr. Baker early went into business with a brother in Chicago, Ill., but, after the great fire in that city, he returned to Cleveland where he taught school for about a year. In 1873, he entered Northwestern University as a student in Engineering but remained only two years; he then transferred to the University of Michigan as a Junior, in the class of 1877, with which class he was graduated, with the degree of Civil Engineer.

After his graduation in June, 1877, Mr. Baker returned first to Cleveland and then to Chicago, where he remained only until April, 1878, when he was appointed Assistant Engineer under the Missouri River Commission at St. Louis, Mo., where, engaged on the design of snagboats and other river boats, he lived until about 1883, when he went to Tacoma, Wash.

During his residence on the Pacific Coast, he was engaged in a variety of engineering work, including Government surveys, precise

* Memoir prepared by William S. Mitchell, M. Am. Soc. C. E.

levels, etc., on the Columbia River. He returned to St. Louis, in 1889, as Assistant Engineer for the Mississippi River Commission, with which he was engaged until 1891, on river improvement, construction of plant, etc.

During the following ten years, Mr. Baker was in private practice and business. He spent the summer of 1897 abroad, touring the British Isles on a bicycle and going also into France.

In 1901, he went into partnership with B. H. Colby, M. Am. Soc. C. E., a classmate at the University of Michigan, under the firm name of Colby and Baker, Consulting Engineers, but after a short period the partnership was dissolved, and Mr. Baker resumed practice alone.

In July, 1905, he returned to the Government service under the United States Engineer Office, at St. Louis, on the design and construction of two large, steel hull, hydraulic dredges, *Fort Gage* and *Fort Chartres,* and many steel barges and other river plant, and was so employed until November, 1908.

During his several engagements with the United States Engineer Office and the Missouri and Mississippi River Commissions, at St. Louis, Mr. Baker's work in design and construction, both in wood and steel, of snagboats, towboats, dredges, pile-drivers, and river vessels and plant of extremely light draft, added greatly to his reputation as a skillful engineer along such unusual lines, and he became a recognized authority in such matters, his advice therein being much sought. Subsequently, he was engaged, from 1909 to 1912, in similar work for the United States Engineer Office and the Mississippi River Commission, at Vicksburg, Miss., on the hydraulic dredge, *Waterway,* and on barges and a floating steel dry dock. In 1912, he was with the Memphis office (Mississippi River Commission), on the towboats, *Nolte* and *Reese;* from 1912 to 1914, with the Little Rock office, on the hydraulic dredges, *Taber* and *McGregor;* and from 1915 to 1916, at the Duluth office, on the steel hull dipper dredge, *Gaillard.* It was while engaged on this last vessel, that he was obliged to retire because of his health which had been failing for several years. During the construction of the many vessels on which he was engaged, he resided for various periods at Vicksburg, Miss., Pittsburgh, Pa., Dubuque, Iowa, Green Bay, Wis., etc.

After his retirement, Mr. Baker's health continued to decline and, for the last two years of his life, he was practically confined to the house and his bed. During these latter years, his home was at Columbus, Ohio, where he died. He was buried in Bellefontaine Cemetery, St. Louis, Mo., on February 20th, 1919.

He was married, in Bloomington, Ill., on June 15th, 1898, to Miss Florine Vimont, daughter of the late John M. Vimont, of St. Louis, Mo., who survives him.

In his youth, Mr. Baker became a member of the Baptist Church with which he maintained connection until his removal to Columbus, when, with his wife, he united with the First Congregational Church, under Drs. Patton and Washington Gladden.

Throughout his entire manhood and professional career, Mr. Baker was marked for his high character and poise, and for his great sincerity, directness, and accuracy of thought. He was an excellent mathematician and an able and accomplished engineer, resourceful and accurate, and a most assiduous worker. His kindliness and simplicity, his loyalty to his work and his friends, and his perseverance and dignity, endeared him to all who knew him.

Mr. Baker was elected a Member of the American Society of Civil Engineers on May 7th, 1890. He was also a member of the St. Louis Engineers' Club.

JAMES CURRIE HALLOCK, M. Am. Soc. C. E.*

Died November 2d, 1918.

James Currie Hallock was born in Treasure City, Nev., on December 8th, 1869. After completing his preliminary studies in his native State, he entered Rensselaer Polytechnic Institute, Troy, N. Y., from which he was graduated in June, 1891, with the degree of Civil Engineer.

Shortly after his graduation, Mr. Hallock entered the service of the Troy Steel and Iron Company of Troy, N. Y., as Assistant to the General Superintendent, remaining until February, 1893, when he entered the employ of the United States Coast Survey Corps which was engaged in deepening the Hudson River for a ship channel, and had charge of the drilling and blasting of a reef at Saugerties, N. Y.

In July, 1893, Mr. Hallock accepted a position with the Government of Ecuador, and until November, 1894, he was Government Engineer and Surveyor-General of the Province of Esmeraldas. In November, 1894, he was employed as Assistant Engineer by the Playa de Oro Mining Company, of Esmeraldas, Ecuador, remaining with that company until May, 1895.

In June, 1895, Mr. Hallock began private practice as Mine Examiner and Expert in San Francisco, Cal., where he remained until August, 1901, when he returned to Ecuador as General Manager of the Southern Exploration and Commercial Company of Ecuador. In October, 1901, he again entered the employ of the Government of Ecuador, as Government Engineer of the Province of Esmeraldas, which position he held until February, 1903, when he was made Director General of Public Works and Chief Engineer for the Government of Ecuador, his duties

* Memoir prepared by M. R. Sherrerd, M. Am. Soc. C. E.

covering the general supervision of public works, such as the construction of highways, bridges, canals, sewerage and water supply systems, public buildings, etc., as well as the inspection and approval of all railroads and other work being done by contract. Mr. Hallock held this position with great credit to himself and the Government until February, 1906, when a revolution took place, throwing the party by whom he was employed from power. When the Government Palace was surrounded by revolutionists, he succeeded in getting through their lines and saved a number of Government records which he turned over to the American Consul.

Returning to the United States, Mr. Hallock became Engineer in charge of field work with the Passaic River Flood Commission of New Jersey, taking up his duties with this Commission in June, 1906. On the completion of this work, he accepted the position as Assistant Chief Engineer of the New Jersey State Water Supply Commission, and, on March 1st, 1909, was made Assistant to the Chief Engineer of the City of Newark, N. J. In February, 1910, the Board of Works created the position of Deputy Chief Engineer, and on February 17th, he was appointed to that office.

In his new position, Mr. Hallock was given direct charge of the meadow reclamation work and the general development of the Port Newark Terminal. The demonstrated availability of the great tract for industrial use is pointed to as a testimonial to his foresight and efficiency. In addition, he was the active head of the City's garbage collection and disposal system, a work in which he also met success.

Possessing a pleasing personality and enjoying widespread popularity, he was active in the civic affairs of Newark, N. J., in addition to his work in an official capacity. He was Chairman of the Executive Committee of the Mayor's Council for National Defense and instrumental in organizing the Home Defense units of the city.

Mr. Hallock severed his connection with the City of Newark in February, 1918, and returned to Ecuador to become Engineer to that Republic. As such his chief task was the suggestion of a system of flood control to curb the annual floods in the River Jubones and to end this serious menace to the chocolate plantations located along that river. Before his death, which occurred in Ecuador on November 2d, 1918, he had submitted a report to the Government for a general scheme to effect such control and was in charge of the inauguration of the work.

He was an active member of the American Society for Municipal Improvements and assisted materially in formulating many of the standard specifications adopted by that Society. He was also a member of the Engineers' Club of New York City and Vice-President of the Traffic Club of Newark, N. J.

Mr. Hallock was elected a Member of the American Society of Civil Engineers on October 3d, 1906.

ARTHUR HAVILAND, M. Am. Soc. C. E.*

DIED JUNE 18TH, 1919.

Arthur Haviland was born at Brooklyn, N. Y., on March 8th, 1848. He was the son of Daniel G. Haviland and Hannah Haviland, who were members of the Society of Friends. His father was one of the originators of Limoges china.

Mr. Haviland received his early education in France and England, and, on his return to the United States, entered Haverford College, at Haverford, Pa., from which he was graduated with the degree of A. B., in 1865.

He began his work as an Engineer in 1869, as Rodman with the San Francisco and Humboldt Bay Railroad, on surveys and construction. From 1869 until 1886, he was engaged on the various phases of railroad engineering—preliminary surveys, location, and construction—in different parts of the United States, including the preliminary and location surveys and maps of the Tehuantepec Interoceanic Railroad and the surveys of the Bar and Harbor of Coatzacoalcos. In 1885 and 1886, Mr. Haviland was employed by Mr. J. D. Crimmins (then President of the Park Board of New York City) as Engineer on his contracting work in New York City.

Leaving the employ of Mr. Crimmins, Mr. Haviland entered the office of the City Engineer at San Antonio, Tex., and, in November, 1886, was promoted to be Assistant City Engineer. In 1887, he returned to New York City on leave to be married.

At this time he accepted a position with the New York Central Railroad Company, in the service of which he remained until his death. While with this Company, he had a prominent part in the depression of the Harlem Division Tracks, between Mott Haven and Woodlawn. Following the completion of this work, he became connected with the Law and Land and Tax Departments, where he pursued lines of work that were of importance and value, and, in that connection, his death will prove to be a severe loss to the Company.

In the course of his work he formed a wide acquaintance with the contents of most of the offices of public records in New York State, and with the public officials attached thereto. He testified as witness for the Company in practically all its important lawsuits, and became known to the judges and the attorneys for his probity, accuracy, and reliance.

Since his marriage, Mr. Haviland had resided in the Borough of the Bronx, New York City, and interested himself locally in many social and civic affairs. He was a member of St. Edmund's Protestant Episcopal Church, and had been deeply interested in all the activities connected therewith, having served as a member and Clerk of the Vestry

* Memoir prepared by Henry Vier, Esq., New York City.

and as one of its Wardens. The large memorial window in the front of the church was presented by Mr. Haviland.

He was always of a cheerful and optimistic disposition, and his loss will be deeply felt by all those who were associated with him intimately, both in business and social life. He is survived by his wife.

Mr. Haviland was elected a Junior of the American Society of Civil Engineers on January 4th, 1882, and a Member on January 4th, 1888.

TIEN YOW JEME, M. Am. Soc. C. E.*

DIED APRIL 24TH, 1919.

By the death of Tien Yow Jeme, at Hankow, China, on April 24th, 1919, China lost one of her most useful engineers in the construction and development of the railways of the country. He was a pioneer among Chinese engineers and, on account of his long service with the Chinese Government railways, his position was unique, and he was credited with enjoying the complete confidence of his Government. Practically his whole life was devoted to the construction of railways, and the story of his career nearly covers the history of railway development in China. He first became a National figure in 1909, when he completed the Peking-Kalgan Railway, a line 125 miles long, through difficult mountainous country, connecting the capital of China with the historical frontier mart of Mongolia. In completing this line, he was the first Chinese engineer to build a railway without foreign help in any capacity.

Tien Yow Jeme was born in Canton, China, on April 26th, 1861, so that he was 58 years old at the time of his death; by the Chinese calendar and the Chinese method of reckoning age, he was 59 years old. His grandparents came from the Province of Anhwei, having migrated to Canton where his father was attached to a mercantile firm.

His education was acquired principally in the United States, where he went in 1872, at the early age of 11. He had studied for a short time in the Chinese Educational Mission School, at Shanghai, previous to being sent to the United States with about twenty-five other youths, comprising the first group of students to be educated there, at the expense of the Chinese Government. During the course of four or five years, the Chinese Government sent altogether 120 students to the United States, and of that number, Mr. Jeme was about the youngest, having been a mere child when he left Shanghai. He was sent directly to New Haven, Conn., and placed in charge of an American family for training, eventually entering the New Haven High School, where he prepared for college. He was among the first of his countrymen to

* Memoir prepared by J. G. Wong, Assoc. M. Am. Soc. C. E.

pass college examinations and, in 1879, he was admitted to Sheffield Scientific School of Yale University. On account of his aptitude for the sciences and for mathematics, he took the course in Civil Engineering. He was a most brilliant student in mathematics, and captured the prize in that subject in both his Freshman and Junior years. He was graduated from Sheffield with a Ph. B. degree in Civil Engineering, in 1881, at the age of 20.

The original Director of the 120 Chinese students was Dr. Yung Wing, the first Chinese to have been graduated from Yale, and, in later years, those students came to be known as "Yung Wing boys". Out of the number, one has been a Premier, one a Cabinet Minister, one an Ambassador, and numerous others have been Railway Directors and Customs Commissioners. On the whole, they have done well, and are worthy products of American education. Intrigues on the part of the Chinese Mandarin Hu caused Dr. Yung Wing to be transferred to be Secretary of the Chinese Legation at Washington, D. C., and Mr. Hu himself became the Director. He had no knowledge of English and was not in the least in sympathy with any new ideas. He had been sent out by the Manchus to watch the activities of Dr. Yung Wing who, the Court feared, might lead the youths astray. After having served as Director for some time, he sent a lengthy memorial to the Throne to the effect that the young men were fast being foreignized, and he thought that on their return they would contaminate China and introduce new and demoralizing ideas; he, therefore, recommended their immediate recall. The result of this action brought about the recall of the 120 students in the autumn of 1881. It was with great reluctance that they returned to China, as several of them were within a few months of receiving their university degrees. Of the 120 young men, only two went home with degrees from the University; they were Mr. Jeme and his classmate at Sheffield, Owyang King, at one time Chinese Consul at San Francisco, Cal.

On their arrival at Shanghai, the students were ordered by the Government to report to the Shanghai Commissioner of Foreign Affairs, who was to distribute them to various places for further training and reform, in order to fit them for Government service. They were literally looked on as plotters, and their every movement was secretly watched by Government agents. Mr. Jeme with fifteen others was sent to the Foochow Arsenal, on the coast opposite Formosa. While at the Arsenal, he took a course in navigation in the Naval School there, and studied under a foreigner by the name of Taylor. After one year of study, he received his certificate and was immediately placed on board a cruiser in the Chinese Navy for further training to become a naval cadet. After a short period on the cruiser he was asked to return to the Arsenal as a teacher in the Naval School. Soon afterward, war with France was declared, and the French squadron began

its attack on the Arsenal, causing confusion in the school. Just at this time the Viceroy of Canton requisitioned Mr. Jeme to go to Canton to build fortifications. His most notable feat while at Canton was his complete survey of the coast line which was mapped out for the first time.

After peace with France was declared, Mr. Jeme was attached to the Canton Military and Naval Academy as an Instructor, where he remained until he was called north by Wu Ting Fang, the former Chinese Minister to the United States, to join the railway service at Tientsin. It was the opportunity for which he had been waiting, the chance to make use of what he had acquired at Yale and to practice the profession to which he had dedicated his life. Wu Ting Fang was at that time the Director of the Tientsin Railway Company.

Mr. Jeme first joined the railway service at Tientsin in 1888, and, thereafter, for 31 years, he was continuously on the payroll of at least one railway. His first appointment was as Cadet Engineer, an assistant to a Resident Engineer. The Tientsin Railway Company was being financed by a British loan, consequently, the Chief Engineer, and all the principal engineers, were Englishmen. The Chief Engineer, Mr. C. W. Kinder, was in charge of the building of a line from Tientsin, passing the Tangshan coal mines, to Shanhaikwan, a Customs outpost on the Manchurian border. The ultimate object of the British was to extend this line past Shanhaikwan to the metropolitan city of Manchuria, as well as to build a line to Peking on the other side of Tientsin, thereby giving a through connection between Peking and Mukden *via* Tientsin, the greatest commercial city in North China. In the construction of the line between Tientsin and Mukden, Mr. Jeme took an active part on both sides of Shanhaikwan. By steady work, he was promoted successively to be Resident Engineer and District Engineer, and, invariably, he was given charge of the end section, the hardest, on account of being the farthest from the base, and, consequently, the most difficult to which to get material and supplies.

At first, the line between Tientsin and Peking was not allowed to be built on account of strong opposition in the capital. It was feared by the leading officials that, with a railway connecting Tientsin with Peking, the position of the capital would be greatly weakened; besides, there was bound to be local opposition from the natives when the railway people started to build through the many ancestral graves in the country districts. It was not until Li Hung Chang came to the rescue that work on the line was started, but the condition was imposed on the engineers that the railway must not come nearer than 10 miles of the capital. Therefore, the line was built to a small unimportant town named Fengtai, about 10 miles south of Peking. Some time after the completion of the railway from Tientsin to Fengtai, Prince Kung wished to go to Tientsin, and, in making the trip, he first had to

travel by his slow-moving mule-cart from Peking to Fengtai, taking nearly a whole day to cover the 10 miles. He then boarded the luxurious train and covered the remaining 81 miles in about 3 hours. The difference in speed and comfort was too great to pass unnoticed, so when the Prince returned to Peking, he lost no time in removing the restrictions which had prevented the railway from approaching the capital. It was on the extension of this 10 miles that Mr. Jeme served as Resident Engineer. Later, when the line from Tientsin to Mukden was completed, both lines radiating from Tientsin were amalgamated into what is known to-day as the Peking-Mukden Railway. In all, Mr. Jeme was connected with the Peking-Mukden Railway for 12 years, during which time he was always on active construction work.

During the Boxer trouble in 1900, when all the northern railways had suspended work, Mr. Jeme joined the Pinghsiang-Liling Railway, as a Construction Engineer. This line was being built to develop the coal mines at Pinghsiang, Kiangsi Province, and to bring the coal to a water route in Hunan Province. The Boxers had destroyed a part of the Tientsin-Peking Line, which caused the Allied troops to occupy the railway, as an English loan was involved. However, as soon as the rising was crushed, the railway was returned to China, and Mr. Jeme was asked to go back to the north to resume his former connection with the company.

In 1901, after the Boxer movement was quelled, the Imperial Court, on its return to Peking from Sianfu, Shensi Province, decided to go to the Imperial Tombs at Hsiling for ancestral worship. On September 20th, 1901, an Imperial Edict was issued expressing the desire of the Court, and, according to the Chinese custom, an Imperial road must be built. In this case, the suggestion of a railway was adopted, and the Court appointed Mr. Kinder as Chief Engineer to survey and construct the line. The French Minister at Peking at once presented a protest against Mr. Kinder's appointment, and asked for the appointment of a French engineer, claiming that, as the proposed line was to branch out from the Peking-Hankow Railway, a French loan line, French engineers should be entrusted with the work. Both the French and the English interests used every means in their power to get the appointment for an engineer of their own nationality, but as they could not compromise, they were forced to agree to the appointment of a Chinese engineer. Mr. Jeme was the logical choice, and, accordingly, he was made Chief Engineer of the Hsiling Railway.

The controversy between the French and English had consumed much time, and only about four months remained before the date set for the Imperial worship. The trains had to be ready by February 22d, 1902, for the local officials who had charge of making the preparations for the worship. Four months to survey, build, and run trains over 28 miles of virgin country! It was in the middle of winter, when

the rivers were all frozen, making transportation of material troublesome; material was scarce and difficult to transport. Old rails were borrowed from the Peking-Mukden Railway, straightened, and used for sidings; the sleepers were spaced farther apart than for ordinary practice, and the large structures were of a temporary nature. During those four months, Mr. Jeme worked about 15 hours a day, and, for many nights, he could not sleep, because he knew that if he failed to have the trains running, he undoubtedly would have to forfeit his life. It was his first trial, and was accomplished under great handicaps, but, fortunately, he was able to satisfy the Court, and the trains were operated for the Imperial Worship. When the Imperial Court had returned safely to Peking, he was rewarded by the rank of Prefect, a great honor in those days. He was also retained to make the roadbed a permanent one. From that time, his name began to be known throughout official ranks, and he became a great favorite of Yuan Shi Kai, then Viceroy at Tientsin, who had had principal charge of the arrangements for the Imperial Worship. Mr. Jeme never forgot the men who had helped him on this work and who had made his success possible.

Mr. Jeme's next important work was in connection with the taking over of the Tao-Ching Railway by the Chinese Government. This road had been built by the Peking Syndicate, an English corporation operating coal mines in North China. The railway is a branch of the Peking-Hankow Line and taps the great anthracite coal deposits of Shansi Province. Mr. Jeme represented the Chinese Government in the valuation of this line, and, later, in 1905, the Chinese Government paid the Peking Syndicate £614 600, the valuation set by Mr. Jeme in conjunction with the General Manager of the Syndicate.

Just about the time that the Hsiling Railway was completed with a permanent roadbed, Mr. Jeme was called to Canton on account of the death of his father. While at Canton, he was asked to join a commercial railway starting at Swatow on the coast. He subsequently went to Swatow, but only stayed there about two months, when he left for Shanghai, to accept a position as Consulting Engineer to the Shanghai-Nankin Railway Administration, which position he retained for nearly a year.

After the Allied Command had handed back the Peking-Mukden Railway to China, the line did a tremendous business and had plenty of money in its treasury, after deducting all operating expenses and meeting all loan obligations. Naturally, the Director wished to make use of this surplus for the construction of more lines; consequently, he recommended the building of the Peking-Kalgan line. Friends of Mr. Kinder in the capital at once started a campaign for his appointment as Chief Engineer of the proposed line. This seemed to be a logical choice, as the money for the proposed line had come from the surplus fund of an English loan railway, and, besides, Mr. Kinder was

admitted to be a capable engineer of proven abilities. However, there was great disappointment among his many admirers when it became known that the Russian Minister at Peking had handed the Chinese Government a protest against his possible appointment, pointing out that China had an understanding with Russia that any railway built beyond the Great Wall toward Mongolia must be financed by Russian capital and built by Russian talent. However, if the Chinese themselves could furnish their own money and men, he had no objection. By that time, Yuan Shi Kai had become a powerful man in the Cabinet, and he took up this challenge of the Russian Minister. He at once sought audience with the Emperor to whom he urged the building of the Peking-Kalgan line; he knew just the man who could do the work, and he recommended that Mr. Jeme be appointed Chief Engineer. Yuan had implicit faith in Mr. Jeme's ability to carry out the project, and, later, it was shown that he had not misplaced his confidence. Thus, it came about that Mr. Jeme received the appointment over his former chief for the second time. It had not been of his own seeking, for he had great respect for Mr. Kinder. It was the inevitable, brought about by the peculiar conditions in each case, for Mr. Jeme was not a man to intrigue for another man's job. Besides appointing Mr. Jeme as Chief Engineer, Yuan Shi Kai had the foresight to make him Vice-Director concurrently, thereby giving him a voice in the Administrative Department. About two years later, he was promoted to be the Director. As the Chief Engineer, Mr. Jeme personally located the line and fixed the grades, and construction began immediately.

It was in the construction of the Peking-Kalgan Railway that Mr. Jeme gave proof of his greatness as an engineer and as an administrator. He inspired his men by his own hard work, and told them that they must succeed, as the eyes of the world were watching them. He impressed on them that whether they failed or succeeded, it was not their own failure or success, but must be shared by many generations to come. There was great team work throughout the ranks, for the men realized the full significance of their undertaking; and to those builders, their Chief, and the Chinese in general, the Peking-Kalgan Railway will stand forever as a monument to their ability and efficiency, and shows what the Chinese are capable of accomplishing when the right leader is found among them.

The Peking-Kalgan Railway cost about 7 000 000 taels complete. Mr. Jeme estimated the cost of the line at 7 223 900 taels, the work to be completed in four years. In his original estimate, he requisitioned for 1 800 000 taels per year, but was given only 1 300 000 taels during the first two years. In spite of this reduction, he completed the work within the scheduled time, and 4% under his original estimate in cost. The average cost per mile was 56 000 taels, equal to about $39 200 in gold, at the rate of exchange at the time. Whatever the critics may

still have to say, the fact remains that a standard in construction cost has been set by a Chinese for the Chinese Government railways. There were reasons for this low cost. First, all the Chinese engineers dealt directly with the contractors, therefore, interpreters who might cause leakages in payments from the railway office to the contractors were not necessary. Then, there was no commission to be deducted at every purchase, as is the case for all foreign loan railways when the foreign purchasing agent is allowed the commission.

After the completion of the Peking-Kalgan Railway, in 1909, Mr. Jeme was retained to carry on the work of extension. He retained his position on this railway until the end of 1911, when the Revolution upset all departments of the Government service. At the opening ceremonies at Peking, Mr. Jeme received a great ovation from the people. It was one of the proudest moments of his life, equalled by only two other occasions, when he was praised by Dr. Yung Wing in the presence of all his schoolmates for capturing the Sheffield Freshman prize in mathematics, and his grand reception at Canton, when he went there to become President of the Canton Section of the Canton-Hankow Railway. In recognition of his great work, Mr. Jeme was given the Honorary Doctorate Degree by the Government. He was also made an Adviser to the Ministry of Education and Consulting Engineer to the Ministry of Communications. In 1910, he was appointed Chairman of the Board of Civil Service Examiners, for the examination of more than 700 men who had been educated in foreign countries.

Directly after the opening of the Peking-Kalgan Railway to traffic, the Viceroy of Szechuen Province sent a petition to the Throne for the second time, asking for the release of Mr. Jeme from Peking, in order that he might take up the construction of the Szechuen Section of the Hankow-Szechuen line. As everything was running smoothly on the Peking-Kalgan Railway, Yuan Shi Kai allowed Mr. Jeme to accept the offer, but still retained him in the service of the Peking-Kalgan line. Accordingly, Mr. Jeme went to Ichang in 1909 to accept the position of Chief Engineer of the Szechuen Railway Company, a privately owned company. The Szechuen line was to start from Ichang, Hupeh Province, and was to open up the Province of Szechuen, with ultimate connection with Hankow. Ichang is a treaty port on the Yangtze River, about 1 000 miles from Shanghai, and is situated just at the mouth of the famous Yangtze Gorges. The Railway Company had previously engaged a young Chinese as its Locating Engineer. He had already spent several years in the Szechuen hills, and Mr. Jeme's part on his arrival was to start the construction of the line. Mr. Jeme did not favor the located line which went inland, away from the Yangtze River, and was, therefore, much longer than a river line. He was of the opinion that a river route was better. However, as several years had already been spent in location work, the Company

would not allow any more time for further investigations. The shareholders were clamoring for results; they wanted to see trains running. The natives throughout the Province were curious to know what a railway was like, they had heard so much of its wonderful performance and yet after spending so much money and waiting for so long, there was no sign of one. In later years, whenever a party of engineers went into Szechuen Province, the natives would invariably say, "coming again"? Mr. Jeme's opinion concerning the river line was afterward confirmed by surveys made during 1913 and 1914 by American engineers under Richard Wood Randolph, M. Am. Soc. C. E., Chief Engineer of the Szechuen Section of the Canton-Hankow-Szechuen Railways. In 1911, the Szechuen Railway Company was taken over by the Government and this action was one of the chief causes of the Chinese Revolution. After the Revolution, the two trunk lines—Hankow to Canton, and Hankow to Szechuen—were amalgamated into one system to be financed by the so-called Group Bankers Loan, composed of British, French, German, and American capital, and the Szechuen line, now known as the American Section, was given over to the Americans as their field of activity.

In 1910, while he was at Ichang, busy getting construction work started, Mr. Jeme was informed that he had been elected President of the Canton Section of the Canton-Hankow line, a privately owned railway, even to this day. After construction at Ichang was under way, Mr. Jeme left for Canton to take up his newly added duties. In order to save money for the Company, he also acted as its Chief Engineer. He had been Consulting Engineer to the Lock-Tung Railway since 1909, so that during 1910 and the greater part of 1911, he was holding six different positions concurrently on four different railways. His time was spent between Peking, Ichang, and Canton.

When the Revolution broke out in 1911, Mr. Jeme was devoting his energies to the extension of the railway at Canton, and the Revolution gave him the chance to prove his faithfulness as its custodian. There was great excitement in and around Canton during the early period of the Revolution. Everybody who could afford it went to Hong Kong for protection under the British flag, but Mr. Jeme remained on the job. His staff threatened to desert him, and his many friends advised him not to take any chances by remaining in Canton. He called together the various chiefs of each department of the railway, and told them that he was going to stick to his post, but that if any one among them was afraid to stay, he could go; however, before they left, everything must be handed over to him or his representative in perfect order. In the end, nobody left, the trains were kept running throughout the Revolution, and the railway did not suffer in any way. A neighboring railway was looted after its Director and principal heads had deserted the place at the first sign of trouble. Everything

that could be carried off was taken, and it was rumored that the remaining staff, mostly of the lower class, looted the railway themselves.

With the abdication of the Manchus, the country was somewhat restored to order, and the Canton-Hankow-Szechuen Railways System was organized. President Yuan Shi Kai sent a delegate to Canton to bring Mr. Jeme to the capital for appointment as Associate Director-General of the System. He was especially charged by Yuan to look after the technical part of the railway administration at Hankow. At the beginning the Director-General's post was reserved as a pension for some Revolutionary hero. It was passed from hand to hand during the first year, and, finally, a politician got the job, but only retained it for about six months when he died. Yuan then appointed Mr. Jeme as Director-General, the date of the appointment having been June, 1914, and from that time until his death, he retained this position. While he was Director-General, on the British Section, the portion between Wuchang and Changsha was completed and opened to traffic; on the German Section, a roadbed was completed for 164 km., but the tracks had been laid for only a short distance when the war stopped further work; on the American Section, no construction was attempted.

Besides the honors already mentioned, Mr. Jeme was appointed to represent China on the Allied Technical Board at Harbin. In 1916, he received the LL. D. degree from the British Colonial University at Hong Kong. He was Chairman of the Technical Committee in the Ministry of Communications, Vice-Chairman of the National Communications Conference, Honorable Member of the Board on Railway Laws and Regulations, Member of the National Transportation Committee, and he was twice decorated by the Chinese Republican Government. In 1916, on the thirty-fifth anniversary of his Class, his Alma Mater offered him the honorary degree of M. A., but he was unable to go to the United States to receive it.

During the construction of the large bridge across the Yellow River, on the Tientsin-Pukow Railway, the work was held up by the local gentry who demanded the addition of more spans. The natives drove off the German engineers and the German contractors and refused to let them proceed with the work. The Director was in despair, as he was unable to cope with the situation. He asked for help from the Government, and Mr. Jeme was sent to investigate and commissioned to do what he could to settle the matter. He not only explained everything satisfactorily to the gentry, but also secured their consent to quarry rubble from a near-by hill, thereby cheapening the cost of rubble. In this mission which required tact and diplomacy, he saved the Government many thousands of dollars.

He was the first to introduce the use of rack-a-rock in China during the construction of the Peking-Kalgan Railway. On every railway of which he had charge, he set a high standard in pay for the Chinese engineers. He believed firmly that Chinese engineers should receive the same pay as European engineers of the same rank and for the same work. He had a warm place in his heart for young engineers, especially for those who had been educated abroad. To them he was an inspiration, and was always looked to for guidance. He was always accommodating to any one who sought his help.

The following story is a concrete example of his silent fight for the good of Chinese engineers. While he was still Associate Director-General, the German Chief Engineer, Mr. Linow, sent an official communication to the Director-General for sanction to send for a number of German engineers of all ranks to replace the Chinese engineers. Mr. Linow said in his letter that "the Chinese engineers were no good" Mr. Jeme was aroused at once by this letter and strongly advised the Director-General that under no consideration must such an application be sanctioned. He clearly saw that if this was allowed, it would create a precedent for the wholesale importation of foreign engineers and likely to be followed by other foreign loan railways. In time, Chinese engineers would disappear from the railway service. The Director-General not wishing to get himself into trouble with the Germans, wired from Peking that the Associate Director-General would have the power to decide the question. Accordingly, Mr. Linow was asked to come to the Director-General's office for consultation. On his arrival, he was asked to re-read his letter to see if it was correct. Mr. Linow replied that the letter was quite correct. Then Mr. Jeme asked him what he meant by the statement, "Chinese engineers were no good". Mr. Linow replied that he only meant those whom he had who were not up to the standard. Whereupon, Mr. Jeme gave the letter back to Mr. Linow and told him that the statement was too broad, he must alter that letter. If, however, Mr. Linow thought the Chinese engineers whom he had were not up to the standard, better ones would be found until he was satisfied. Mr. Jeme also told him that if any Chinese engineers were dismissed, the vacancy must be filled by Chinese according to the loan agreements. He also expressed the opinion that he did not believe it would be just for any foreign loan railway to import foreign engineers to fill all the ranks; it was all right for experienced foreign engineers to take the principal positions, but the lower ranks ought to be reserved for the Chinese to get the practice and training. In the end, Mr. Linow saw the justice of Mr. Jeme's refusal, and acted accordingly. This was one of many such cases, where Mr. Jeme took the burden on his own shoulders for the good of the Chinese in general.

As time goes on, Mr. Jeme's record of achievements will undoubtedly receive greater recognition. He was always a clear thinker and a man of few words. In his long years of toil, he was never known to have made an error in judgment, and although a man of strong convictions, he was always open to argument and ready to receive suggestions and give them consideration. He was never known to fail in keeping a promise, and was always punctual at his office, at meetings, or at social functions. Between him and those who were with him through his early struggles, there existed a deep and sincere affection. To the older class of Chinese engineers, he was always their leader, one to whom they always went for advice and help. He was frank, open in his dealings, honest to the core, and above petty personal interests. He was a true gentleman at all times, courteous to all, and possessed of high moral conceptions.

He was a man of the most simple tastes, modest in the extreme, and never harbored resentments or belittled those who opposed him; he was never jealous of the man above him. He always considered himself as an engineer, and never mixed in politics. When the Revolutionary party asked him to join their ranks, he refused politely saying that he was only an engineer, one who was to make progress by his creative and constructive endeavors. He was one of the founders of the Chinese Institute of Engineers, and obtained its recognition by President Li Yuan Hung. It was his aim to give the Society a standing that would qualify its members to accept any technical post under the Government. Through his efforts, several thousand dollars have been collected toward a building fund for the Society, and Mr. Jeme secured temporary quarters in Peking for it. Whenever he was in Peking, he always stayed at the Society headquarters in preference to the luxurious hotels.

He was a lover of the American game of baseball and, on his return trip in 1881, he played on the All-Chinese team organized by the returning students. The All-Chinese team played an exhibition game with an Oakland semi-professional team and surprised the Americans by their excellent playing. He took a keen interest in the Yale ball team and followed its history through his alumni papers. He was enthusiastic over tennis, and occasionally played a set or two with his children. He lived a clean life, and had never known sickness until about a year ago, when he was first attacked with dysentery from which attack he never fully recovered. During the past year, his health began to fail rapidly, but he stayed at his work, hoping all the time that he would soon be well again. He was in poor physical condition when President Hsü sent him to Harbin to represent China on the Allied Technical Board. The long journey and the strain of the work had their telling effect, for three days after his return to Hankow

on a short leave, he was advised to enter the hospital for careful treatment.

On his arrival at Hankow, he had decided to request President Hsü to release him from all public duties, and had asked his Secretary to prepare his resignation, which he had just time to initial, when he passed away at the hospital. According to the doctor who attended him, his death was due to heart failure and overwork.

In his valedictory petition to the President, Mr. Jeme urged the training of more engineers, with every chance for practice, recommended the appointment of a competent expert to succeed himself on the Allied Technical Board, and, finally, the speedy completion of the Canton-Hankow-Szechuen Railways, especially the Szechuen line, on the great future of which all engineers, travelers, writers, merchants, and missionaries have agreed.

On his death, President Hsü issued a mandate in which he commanded the National Historian Committee to record Mr. Jeme's deeds in the history of the Nation, donated the sum of $2 000 toward defraying the funeral expenses, and ordered the Civil Governor of Hupeh Province to represent the Government at the funeral services at Hankow in offering sacrifices. Mr. Jeme's many friends at Canton, Shanghai, Tientsin, Hankow, and Peking held memorial services to pay him tribute.

Mr. Jeme was elected a member of the Institution of Civil Engineers of Great Britain in 1894. He was also a member of the Royal Academy of Arts and of the Shanghai Engineering Society (Europeans), President of the Chinese Institute of Engineers, President of the Hankow Foreign Educated Men's Club, member of the Chinese Railway Association, and while at college, a member of the Alpha Phi Fraternity.

He was married in 1887, at Canton, and his widow, five sons, two daughters, one brother, and one sister survive him. His two eldest sons had only returned from the United States, in February, 1919, one having been graduated from Yale in Civil Engineering and the other from Tri-State College in Mechanical Engineering.

The following telegram and letters show in what high esteem Mr. Jeme was held by those who knew him and who had been associated with him:

The following telegram of condolence was received from the Hon. Paul S. Reinsch, the American Minister to China:

"We are greatly shocked by information of death of Dr. Jeme whose efficient services to Chinese railway development and whose eminent qualities of character gave him a distinguished position of confidence with all Americans."

John F. Stevens, M. Am. Soc. C. E., President of the Inter-Allied Technical Board, wrote as follows:

"Dr. Jeme was known to me somewhat by reputation before I had the pleasure of his acquaintance, and I am glad to believe, his friendship. During the short time I was associated with him in our work on the Allied Technical Board, I was deeply impressed by his quick grasp of any matter which we had under consideration, his rapid, and to my mind, excellent judgment.

"While a man of few words, he was decisive, and we all greatly respected his opinions, and one could readily see that, coupled with a thorough technical knowledge of railway problems, he possessed what was even more valuable, strong common sense and a thorough belief in his convictions.

"Above all, he was a gentleman, and the great pleasure I have in the memory of his association, is only equalled by the sense of loss not only personal to all of us, but a very great one to his country."

C. J. Carroll, M. Am. Soc. C. E., Chief Engineer of the American Section of the Canton-Hankow-Szechuen Railways, wrote:

"During the past two years that I have been associated with the late Dr. Jeme in affairs of the Szechuen-Hankow Railway, I have always found him deeply and personally interested in the ultimate success and completion of not only this railway, but also in a broader sense the comprehensive railway development of China.

"Dr. Jeme was recognized as the leading Civil Engineer of China on account of his technical ability, of which I had many occasions to observe, as a man of real accomplishment such as the carrying through to completion and success the Peking-Kalgan Railway, and as a man of broad ideals, interested and enthusiastic in the development of China's transportation system as a whole.

"All who came in contact with Dr. Jeme could not help but admire not only his ability as an administrator, a conceptor, and an engineer, but his interesting personality and gentlemanly instincts which inspired confidence.

"At the time of his death he was looking forward to the success of his great ideal, the opening up of Szechuen by a railway through the noted and difficult Yantze Gorges. By his death, China has suffered a great loss and I trust that further honors will be conferred upon this noted man by the nation."

The following letter was received from H. A. Raider, Assoc. M. Am. Soc. C. E., former District Engineer of the American Section of the Canton-Hankow-Szechuen Railways:

"The writer had the happy experience of having been associated professionally with Dr. Jeme Tien Yow, and expresses his deep feelings at the loss of a friend and of an engineer who had become of inestimable value to his country in the development of her numerous railway systems.

"Dr. Jeme was without doubt the ablest engineer that China has produced, and might well be called the Father of Engineering in China, because not only of having been the first Chinese Engineer to build and operate entirely with Chinese a large and difficult railway undertaking, but because he was always the first to contribute to, encourage,

and maintain any society or measure that would promote the science of engineering in China.

"He was a man of great ability, possessing fine personal qualities, and commanding the good will and confidence of all his associates. He undertook with enthusiasm and characteristic attitude of duty, every assignment made him by his Government, even to his last, which was indirectly responsible for his early death.

"I trust the young engineers of China will set him up as a model, a man who followed his profession because his country needed engineers, when with his ability he might have amassed wealth in commercial life."

Mr. Jeme was elected a Member of the American Society of Civil Engineers on November 30th, 1909.

ROBERT EMMET McMATH, M. Am. Soc. C. E.*

Died May 31st, 1918.

Robert Emmet McMath was born in Varick, Seneca County, N. Y., on April 28th, 1833. One of the vivid recollections of his childhood was going with his parents to Little Falls, N. Y., to see the first passenger train go through that place on its trip from Schenectady to Utica.

When he entered Williams College from which he was graduated in 1857, he found that he was handicapped by the deficiency of his preparatory course, particularly in the languages, as compared with men who had prepared at Andover and other Eastern schools. While at Williams, he was a fellow student of the late President James A. Garfield, through whose influence he became a member of what was known there as the Anti-Secret Society.

In the latter part of October, 1858, Mr. McMath went West and settled in St. Louis, Mo. He entered directly on the active practice of his profession, his first work having been the design and reconstruction of a levee around Columbia Bottom at the junction of the Mississippi and Missouri Rivers.

From 1859 to 1862, he served as Deputy County Surveyor of St. Louis County, Missouri. In 1862, he entered the employ of the Government as an Assistant Engineer with the United States Coast Survey, under the late Alexander Dallas Bache, Hon. M. Am. Soc. C. E., as Superintendent. While awaiting orders, Mr. McMath made a reconnaissance survey of the environs of Philadelphia, Pa., until the spring of 1864, when he was ordered to Washington, D. C., to report to Gen. Meigs, Quartermaster Corps, U. S. A., for duty. Under orders from Gen. Meigs, he made a topographical survey of Arlington Heights.

* Memoir prepared by the Secretary from information on file at the Headquarters of the Society.

This property was owned by the Lee family, but had been confiscated by the Government for use as a burial ground for soldiers dying at or near Washington, and is now known as the Arlington National Cemetery.

Early in February, 1865, Mr. McMath, with others of the Coast Survey, was ordered to Nicaragua, where the Central American Transit Company, under grant from the Nicaraguan Government, was about to make a survey for the Nicaragua Canal. On this detail, he was engaged on a survey of Greytown Harbor and about 1 000 miles of the San Juan River which at that time was bordered on each side by an unpenetrable wilderness. Until their return to New York, the members of the party had not heard of the surrender of the Confederate Army or the assassination of President Lincoln, and during the voyage home had been continually apprehensive of capture by a Confederate cruiser.

In the fall of 1865, he received and accepted an offer of a position as Assistant Engineer with the U. S. Engineer Corps. His first work in this capacity was on the survey of the Illinois River from La Salle, Ill., to the Mississippi River. In 1867 and 1868, he had charge of a hydrographic survey of the Illinois River, and, in 1869, he was engaged as Assistant Engineer on a survey of the Arkansas River until September, when he was placed in local charge of the improvement of the Illinois River, as part of a canal and slack-water navigation from Chicago, Ill., to the Mississippi River. It was while he was engaged on building dams in the Illinois River that Mr. McMath applied the practice of lumbermen of using brush and stakes, with such ballast as might be available, a method afterward used to a great extent in similar work on the Mississippi and other rivers.

Mr. McMath remained on the work of the improvement of the Illinois River, until July, 1872, when appropriations having been made by Congress for the improvement of the Mississippi River, he was assigned, in August, 1872, to take charge of the improvements of the harbors of St. Louis, Mo., and Alton, Ill. In April, 1873, he was appointed Principal Civil Assistant on the improvement of the Mississippi River, between the Illinois and Ohio Rivers, and, in October, 1878, he was put in charge of special physical investigations thereof. He served with the Mississippi River Commission on similar work from 1880 to 1883, when he was appointed Sewer Commissioner of St. Louis, under Mayor Ewing, which position he held until 1891.

Mr. McMath had never had any experience with sewer work prior to his appointment as Sewer Commissioner, but when the opportunity of doing important and necessary work for the city thus presented itself, he did not hesitate to accept it. During his incumbency of the office, he originated the drainage scheme for what is known as the Vandeventer District of St. Louis, which had presented problems that had

been stumbling blocks of long standing to the Department. Under his direction, a complete topographical survey of the city was made, which is still referred to in planning sewer extension. He also made a special study of the question of the size of sewers required to serve large areas, and embodied the results of these studies in a paper* which was presented before the Society. The formula given in that paper for determining the expected discharge of storm water from areas exceeding 100 acres, known to engineers as the "McMath formula", was widely accepted and used by engineers throughout the country. It has been stated that, in this formula, Mr. McMath "had no idea that he was contributing anything but a method to engineering science and really did not think that he did."

From 1891 to 1893, Mr. McMath was engaged in the private practice of engineering as a Consulting Engineer, in St. Louis. In April, 1893, he was nominated and elected to the office of President of the Board of Public Improvements of St. Louis, and served in that capacity until 1901. In this position he was obliged to familiarize himself with all kinds of municipal problems. He was a prominent member of the City Hall Commission, under the control of which the present City Hall was built, and this building was constructed largely along the lines suggested by Mr. McMath.

After severing his connection with the City Government in 1901, Mr. McMath engaged again in the private practice of his profession as a Consulting Engineer, retaining his office in St. Louis, until he retired a few years before his death, on May 31st, 1918, to his home in Webster Groves, Mo.

Mr. McMath was married in 1859 to Miss Frances Brodie, of Detroit, Mich.

He was a prominent member of the Engineers Club of St. Louis and had been identified with its activities almost from its organization. He served as its Vice-President in 1885, and was elected its President in 1886. He also served as Club Librarian from 1891 to 1893, and was elected an Honorary Member in 1910. The following extracts are taken from a memoir of him, prepared by Robert Moore and John A. Ockerson, Past-Presidents, Am. Soc. C. E., and M. L. Holman, M. Am. Soc. C. E., for the Club:

"While his career was marked by unusual service, this was only natural for one of his remarkable ability. His integrity was as pronounced as his professional capabilities and considered both as a man and as an engineer nowhere in contemporary history can there be found a character more worthy of emulation. Sincere, always most assiduous in his effort to reach the best solution for the problems that he was set to master, a wide reader and a ready writer, his thoroughness gave his contributions to the affairs that claimed his attention the

* "Determination of the Size of Sewers", *Transactions*, Am. Soc. C. E., Vol. XVI, p. 179.

stamp of authority and finality. As one of his associates has aptly said 'when Robert McMath gave his opinion on a subject you knew that it was the result of careful, conscientious study, enhanced by a wide experience and determined by a splendidly trained mind.'

"During the period of his association with the Mississippi River Commission, Mr. McMath was regarded as the best informed engineer on river hydraulics in the country. The elaborate reports which he compiled from time to time were considered as standard and conclusive on many of the problems pertaining to the regulation of the river."

* * * * * * *

"Personally, though a man of few words, his friendship could always be counted upon, and he was generous to the last degree, both in the assistance he rendered his colleagues and in the aid he extended to the young men associated with him who were just growing up in the profession.

"The life of Robert McMath presents one of those rare instances where personality has embraced intellect, sensibility and will of the highest order, each happily balanced against the other and forming a character of charm and power.

"Those of us whose privilege it was to have known him cherish the memory of our association together. The State and society have been enriched by his example of uprightness and his constructive achievements."

The following paragraph is quoted from Mr. McMath's autobiography, and is a fitting close to an account of his life:

"As is the usual lot of men, I have had opportunities for usefulness, and if it has not fallen to my lot to accomplish any great work, I have lived at a time when great advances were being made in matters affecting the welfare of men of all classes and kinds. The material advances and changes have affected all classes and conditions of mankind, and the most that any of us can claim is that we have not failed to meet the responsibilities of the hour and to do what was given us as our work."

Mr. McMath was elected a Member of the American Society of Civil Engineers on March 3d, 1880. He also served as a Director of the Society in 1889.

HENRY KINDER OWENS, M. Am. Soc. C. E.*

DIED MAY 15TH, 1919.

Henry Kinder Owens, the son of William D. and Mary J. (Milham) Owens, was born in Wilmington, Del., on October 9th, 1858. Early in his life, the family removed to Missouri where the boy acquired his basic professional education, obtaining a C. E. degree in 1880.

* Memoir prepared by A. V. Bouillon, M. Am. Soc. C. E.

Following his graduation, Mr. Owens engaged in railroad location and construction work in Missouri, Arkansas, and New Mexico. He went to the State (then Territory) of Washington in 1886 and began to interest himself in irrigation projects, in conjunction with railroad development, in Eastern Washington and Oregon. In 1887, he located in Seattle and was engaged as Construction Engineer on the Seattle, Lake Shore, and Eastern Railway, now a part of the Northern Pacific System.

In 1888, Mr. Owens entered into partnership with the late John G. Scurry, under the firm name of Scurry and Owens, and from 1888 to 1890, inclusive, this firm did the engineering work of the City of Seattle, including the replatting and regrading of the business district following the disastrous fire of June 6th, 1889. The firm also participated in the original plans of the present water supply and sewerage systems of Seattle, in collaboration with the late Benezette Williams, Consulting Engineer, of Chicago, Ill. The firm dissolved in 1892, and Mr. Owens planned and constructed water-works plants for some of the smaller communities in the State of Washington.

From 1893 to 1897, he held a special assignment with the Land Department of the Northern Pacific Railway Company, as Irrigation Engineer, in which capacity he made examinations, preliminary surveys, and reports, with estimates of construction costs, for projects embracing a large part of the irrigable lands in the land grant of that company, in Oregon, Washington, Idaho, and Montana. In 1898, he became Consulting Engineer for the Northern Pacific Irrigation and Land Company, in the execution of a project watering 110 000 acres in Yakima Valley. This project has been in successful operation for nearly 20 years.

Thereafter, he was Chief Engineer of the Hanford Irrigation and Power Company, as well as the Pasco Power and Water Company, and works of magnitude were built under his direction.

From 1908 to his death, Mr. Owens maintained an office in Seattle, as Consulting Engineer, in which period he successfully carried out many undertakings in hydraulic and railroad work, as well as in mining, sewerage, irrigation, and power plants, including among others, notably, the 20 000-kw., hydro-electric plant known as the Puntledge River Plant, built in 1911-13 for the Canadian Collieries, Limited, one of the McKenzie and Mann corporations in British Columbia. He also developed preliminary plans and estimates for numerous hydro-electric projects in Western Washington, and was interested in the development of the steel and nitrate industries in conjunction with hydro-electric power for this district. During part of this period (1911-17), he was associated with A. V. Bouillon, M. Am. Soc. C. E., also a Consulting Engineer of Seattle.

Mr. Owens possessed a genial character which was a source of pleasure to his associates. Always unassuming in manner, he never claimed the professional distinction to which his ability and accomplishments entitled him.

He was married on May 5th, 1887, at North Yakima, Wash., to Miss Alice M. Cock, who, with two sons, Henry Victor Owens, of Seattle, Wash., and Lieut. Theodore Owens, A. C. U. S. N., now at the Naval Air Station, Hampton Roads, Va., survives him. He is also survived by his mother Mrs. Mary J. Owens, and a sister, Mrs. Mary J. Hansberger, both of Sedalia, Mo., and two brothers, Will M. and Fred J. Owens, of Atlanta, Ga.

Mr. Owens was elected a Member of the American Society of Civil Engineers on March 6th, 1889.

HERMANN FREDERICK AUGUST SCHUSSLER, M. Am. Soc. C. E.*

DIED APRIL 27TH, 1919.

Hermann Frederick August Schussler was born in Rastede, Germany, on August 2d, 1842. He came to California from Europe in 1864, after having spent two years in the study of hydraulic and mechanical engineering at the Zurich, Switzerland, and Karlsruhe, Germany, Polytechnic Schools. He gained his first practical experience on engineering work during vacations, having been employed on railroad and bridge work at Lucerne, Switzerland, and as a Mechanical Draftsman at Bremen, Germany.

As early as October, 1864, Mr. Schussler entered the service of the Spring Valley Water-Works (now the Spring Valley Water Company) which supplies water to San Francisco, Cal. He was advanced to be Chief Engineer in 1866, and served in that capacity for 42 years, until 1908, when he was relieved from active charge; he was retained by the Company in an advisory capacity, and continued in private practice as a Consulting Engineer.

During his long connection with the Spring Valley Water Company, Mr. Schussler was more than Chief Engineer of the Company's system. It fell to him to forecast the future water requirements of San Francisco and to take such measures from time to time as would put the Company in a position to meet the constantly growing demand for water. One near-by source after another was added to the System and, by the acquisition of large areas of land in the water-sheds, tributary to the storage reservoirs on which the supply to the city is dependent, the quality of the water was safeguarded. Ownership

* Memoir prepared by C. E. Grunsky, G. A. M. Elliott and F. C. Herrmann, Members, Am. Soc. C. E., a Committee of the San Francisco Association of Members of the American Society of Civil Engineers.

of the water-sheds has made it a simple matter to police the areas in which pollution would otherwise be possible.

During his 42 years of active charge as Chief Engineer of the Spring Valley Water Company, Mr. Schussler designed and constructed all the works of the Company, the aggregate cost of which during that time reached about $20 000 000, and which include such notable achievements as the Crystal Springs Dam, a gravity section concrete structure, and a number of lines of riveted wrought-iron pipe, the service of which for 30 to 40 years, with only moderate deterioration, is most gratifying evidence of the care with which the material for their construction was selected and with which their construction was supervised.

As early as 1870, in the capacity of Consulting Engineer to a mining company, Mr. Schussler designed a 30-in. pipe line, an inverted siphon, more than 3 miles in length, across Feather River Canyon, the success of which went far to give engineers confidence in the use of riveted wrought-iron pipe. He was Engineer for the La Grange Mining Company in 1871-72, constructing for this company the mining canal from near Dom Pedro Bar, on the Tuolumne River, to near La Grange; he made surveys and triangulations for the control of the alignment of the Sutro Drainage Tunnel; he constructed the earth dam for the Lagunitas Storage Reservoir in Marin County, California, as well as the 7-mile, 12-in. pipe line for the water supply of Virginia City, Nev., in 1872-73. His activities extended to the Hawaiian Islands where he was Consulting Engineer for the Haiku Ditch Company, Island of Maui, and constructed about twenty wrought-iron, riveted, asphaltum-coated pipe lines on that island. He designed the sewer system for Coronado Beach, and was consulted on many other engineering problems.

In 1904, Mr. Schussler was asked by the late President Roosevelt as to his availability to become a member of the Isthmian Canal Commission and, a year later, in 1905, he was appointed, but did not serve, on the Board of Consulting Engineers which was named by the President to consider the question of whether the Panama Canal should be built as a sea-level canal or should be of the lock type.

The last notable structure which was carried to completion under Mr. Schussler's direction was the dam across the Klamath River, California, erected for the California-Oregon Power Company, and generally referred to as the "Copco" Dam. This is a concrete structure of the gravity type, notable for the fact that it closes a narrow subsurface gorge, 120 ft. deep, from which a gravel deposit had to be removed. The dam, in the main, was constructed on the interlocking block system, of quite dry concrete, requiring ramming — a system positive in results and much favored by Mr. Schussler.

On all the work in his charge, he was never satisfied with any that would just pass, that was "good enough". He insisted that it must be "first class", and the results he obtained speak for themselves.

To those who worked with him, and to all with whom he came in contact, he was kind and considerate, and he was successful in commanding a loyalty of subordinates that could only be the result of respect and appreciation of his honesty of purpose and his affectionate and sympathetic nature. He remained vigorous in body and mind to the day of his death.

Mr. Schussler was a good citizen, a thorough believer in American ideals, and enjoyed association with his fellow men. He was very fond of European travel, having made some twenty trips abroad, where he kept up his affiliations with the prominent engineers of England, France, and Italy.

He was married to Miss Louise A. Menges, on March 11th, 1869, and is survived by his widow and three children, Mrs. Martin Preuss, Alice C. Schussler and Dr. Hermann Schussler, Jr.

Mr. Schussler was elected a Member of the American Society of Civil Engineers on February 4th, 1914.

FRED CASWELL STANTON, M. Am. Soc. C. E.*

DIED JANUARY 24TH, 1919.

Fred C. Stanton, son of Fred O. and Rebecca Stanton, was born at Vineyard Haven, Mass., on June 7th, 1880. He attended the Vineyard Schools, and was graduated from Marion Academy and, later, from Dartmouth College, taking both the B. A. and C. E. degrees.

During one of his vacations, while attending the Thayer School, Mr. Stanton was employed at Cape May, N. J., on the harbor protection work, under the Engineer Corps, United States Army.

After his graduation, he was employed by the same Department on the improvements of the Brazos River, Texas, under Maj. Jadwin, U. S. A. He was stationed at Houston, Galveston, and at various points along the Brazos River. He was also employed on the Rio Grande River, on the Texas border, and built the ship channel between Houston and Galveston.

When Gen. George W. Goethals, M. Am. Soc. C. E., was put in charge of the construction of the Panama Canal, Mr. Stanton as Civilian Engineer was engaged on concrete construction and dredging in the Canal Zone. Later, he was advanced to the position of First Assistant Engineer of the Atlantic Division of the Panama Canal, under his former chief, Maj. Jadwin, and, later, under Gen. W. L.

* Memoir prepared by J. M. Clack and R. B. Kyle, Associate Members, Am. Soc. C. E.

Sibert, M. Am. Soc. C. E. He designed and constructed the harbor works for the protection of the new harbor at Cristobal, including both the great breakwater at Toro Point and the Eastern Breakwater.

After some eight years of service in the Canal Zone, his health, and also that of Mrs. Stanton, was affected by the tropical climate, and this, with the desire to engage in business for himself, led him to resign from the Canal service in March, 1914.

Mr. Stanton returned to the United States and organized the Stanton-White Dredging Company, which company purchased a number of dredges and engaged in work on reclamation projects in the Mississippi Valley. This work continued until 1918, when labor troubles, occasioned by the draft, considerably restricted the operations of the firm.

On the entrance of this country into the war, Mr. Stanton was very desirous of enlisting in one of the active branches of the Army, but on the advice of friends who knew his qualifications as an engineer and his familiarity with maritime affairs, he was offered, and accepted, a position with the United States Shipping Board, Emergency Fleet Corporation, as District Plant Engineer of the Southern District, with headquarters at Jacksonville, Fla. He was enthusiastically engaged in this work, when stricken with influenza in January, 1919, which developed into pneumonia, and he passed away at the hospital, in Jacksonville, on January 24th, 1919.

Mr. Stanton was married to Elizabeth Stokes, of Jersey Shore, Pa., on October 25th, 1909, who survives him. Mrs. Stanton always accompanied him to all the positions he held from the date of their marriage.

His organization in the Emergency Fleet Corporation and his many friends are left to mourn the loss of a real executive and a true friend.

Mr. Stanton was elected an Associate Member of the American Society of Civil Engineers on April 1st, 1908, and a Member on December 31st, 1913.

GUSTAVO ADOLFO DUBOIS, Assoc. M. Am. Soc. C. E.*

DIED AUGUST 30TH, 1918.

Gustavo Adolfo Dubois was born at Matanzas, Cuba, on September 25th, 1882. He was a graduate of the Massachusetts Institute of Technology, having received, in June, 1908, his degree of B. S. in Civil Engineering.

After his graduation, Mr. Dubois returned to Cuba and entered the employ of the Public Works Department of the City of Havana, as Assistant Engineer in the Department of Civil Construction. In

* Memoir prepared by G. A. Hernández, Esq., Havana, Cuba.

October, 1909, he was appointed Resident Engineer in charge of water-works construction at Cienfuegos, Cuba. As such, he had immediate supervision over the construction of the 10 000 000-gal. reinforced concrete reservoir for the storage of the city water supply, work representing an outlay of $240 000, and also directed the survey and design of various other structures in connection with the new water-works.

From Cienfuegos, Mr. Dubois was called to Havana as Assistant Engineer in charge of sewer and drain construction under D. E. McComb, M. Am. Soc. C. E., then Chief Engineer of the Department of Sewers and Paving of the City of Havana, starting on his new duties in September, 1910. He was closely associated with the work of designing and constructing the sewerage system of the entire city, the cost of which amounted to about $15 000 000. He remained with the Department for three years, until September, 1913, when, the work of construction being nearly finished, he accepted, at the special request of the late Dr. Enrique Nuñez, then Secretary of Health of the Republic of Cuba, an appointment as Chief Engineer of the Sanitary Department of the Republic.

Mr. Dubois' early connections with sanitary projects and construction, and his specialization in Sanitary Engineering while at college, well fitted him for his new responsibilities, and it was a credit to his efficiency and executive ability that, in spite of several political changes, he was able to win the confidence of the successive Administrations under which he was called to serve. During his connection with the Sanitary Department of Cuba, he was influential in helping to maintain the high degree of sanitary standards which have placed the largest cities of the Island, Havana specially, among the most healthful in the world.

In February, 1918, Mr. Dubois resigned his position with the Sanitary Department, to accept the management of one of the leading industrial concerns of Havana, the "Tropical" Brewery, pertaining to the Nueva Fábrica de Hielo, a company owning and operating the two largest breweries on the Island. He had hardly started on his new duties when, after a short illness, he died on August 30th, 1918.

Mr. Dubois was one of the leaders of the young generation of Cuban engineers who, educated at the leading American universities, have contributed so much toward the development of Cuba's resources, making this little Island one of the most prosperous in the world. His early death, at the time when success was beginning to crown his untiring efforts, will be regretted by all who had had personal contact with him and could appreciate the sterling qualities of his character.

Mr. Dubois was married in 1909, to Miss Rita M. Lavastida, of Matanzas, Cuba, who, with a daughter and his mother, survives him.

He was a Member of the Cuban Society of Engineers, and also held the degree of Civil Engineer from the University of Havana.

Mr. Dubois was elected a Junior of the American Society of Civil Engineers on September 1st, 1908, and an Associate Member on May 6th, 1914.

ROBERT DWIGGINS MONTEITH HENLEY, Assoc. M. Am. Soc. C. E.*

DIED MAY 3D, 1918.

Robert Dwiggins Monteith Henley was born near Richmond, Ind., on February 15th, 1879.

During his summer vacations of 1898 and 1899, Mr. Henley was employed as Rodman with the Cleveland, Cincinnati, Chicago, and St. Louis Railway Company.

In October, 1899, he entered the employ of the Louisville and Nashville Railroad Company, as Draftsman in the Mechanical Department. He remained with this Company until November, 1904, serving as Draftsman in the Chief Engineer's Office, Assistant to the Resident Engineer, Resident Engineer, and Assistant Engineer on the Pensacola, the Pensacola and Atlantic, the Birmingham, Selma, and New Orleans, and the Southern Alabama Divisions, of that Company.

From December, 1904, to May, 1905, Mr. Henley was a student at the Central University of Kentucky, but returned to the Louisville and Nashville Railroad Company as Draftsman in the Chief Engineer's office. During September and October, 1905, he was employed as Draftsman in the Bridge Engineer's office of the Cleveland, Cincinnati, Chicago, and St. Louis Railway Company.

In October, 1905, Mr. Henley entered the service of the Chicago, Rock Island, and Pacific Railway Company, and, until April, 1906, was engaged as Resident Engineer for the Morris Terminal Railway Company. From April to June of the same year, he served as Assistant Engineer in charge of the construction of the Morris Terminal Railway and the Kaw River Bridge, at Kansas City, Mo., and, from June, 1906, to February, 1907, he was employed as Assistant Engineer in charge of the Rose Hill Coal Spur near Oskaloosa, Iowa. After the contractors had finished their work, Mr. Henley had charge of the organization of the force to move about 80 000 cu. yd. of material, of which about 30 000 cu. yd. was classified. From March to October, 1907, he served as Transitman on location and as Estimator for proposed grade reduction work for the Railway Company.

In October, 1907, Mr. Henley left the service of the Chicago, Rock Island, and Pacific Railway Company to enter Earlham College, Richmond, Ind., as a special student, where he remained until May, 1908. At that time, he was employed as Building Superintendent for

* Memoir prepared by the Secretary from information on file at the Headquarters of the Society.

the Murry Sun Amusement Company, in charge of the construction of the Murry Theater at Richmond, Ind.

In August, 1908, he entered the employ of the Atchison, Topeka, and Santa Fé Railway Company as Building Inspector, and also as Designer of reinforced concrete work, with headquarters at Topeka, Kans. Mr. Henley retained this position until 1912, when he went to the Kansas City Southern Railway Company. While with this Company he was connected with the work of the Chief Engineer's office, at Kansas City, Mo.

In 1913, Mr. Henley accepted a position as Assistant Engineer with the Central Coal and Coke Company of Kansas City, Mo., which position he held at the time of his death which occurred on May 3d, 1918. While with this Company, he was engaged in the design and supervision of various improvements around its mines, yards, and saw-mills.

He was a comparatively young man, and with his wonderfully brilliant mind and his wide experience in the various branches of engineering, he no doubt would have attained an eminent position in the Engineering Profession, had he lived.

Mr. Henley was elected a Junior of the American Society of Civil Engineers on September 3d, 1901, and an Associate Member on January 31st, 1911.

PAUL ROBERT KIRSTEIN, Assoc. M. Am. Soc. C. E.*

DIED OCTOBER 17TH, 1918.

Paul Robert Kirstein was born at Cincinnati, Ohio, on April 20th, 1888. He finished his preparatory course for college in the Technical School of the University of Cincinnati in 1905, and, in 1909, he was graduated from Purdue University, receiving the Bachelor of Science Degree in Civil Engineering.

Mr. Kirstein's first work was with the United States Coast and Geodetic Survey as Topographical Draftsman, which position he retained for three months.

In 1909, he entered the Engineering Department of the City of Cincinnati, where he remained until 1916. His first work was with the Highway Division and, later, with the Sewer Division. In 1911, he was transferred to the Division of Structures where he was engaged on the design of various small works such as concrete steps, culverts, bridges, etc. In 1912, he was appointed Inspector of reinforced concrete work on the Gilbert Avenue Viaduct, a structure costing about $250 000. During 1913 and 1914, Mr. Kirstein was employed as

* Memoir prepared by Frank L. Raschig, M. Am. Soc. C. E.

Assistant Resident Engineer on the Ludlow Avenue Viaduct, a reinforced concrete structure costing about $350 000, and in 1915 and 1916, he served as Resident Engineer on the Hopple Street Viaduct, a reinforced concrete structure costing about $430 000. After finishing this work, he was engaged on the design of various concrete structures, the principal one of which was the McMillan Street Bridge, estimated to cost about $150 000.

When the work of planning the proposed rapid transit system for the City of Cincinnati was commenced in 1917, Mr. Kirstein was appointed Designing Engineer for the Board of Rapid Transit Commissioners. His work in this connection was on the design of the various structural features such as subway, reinforced concrete elevated structure, trestles, etc. He held this position at the time of his death.

Mr. Kirstein was a very capable and energetic young man, of high character and pleasing personality. His untimely death closed a promising career and was a distinct loss to the Engineering Department which he served.

He was married, on September 26th, 1914, to Miss Freda Kohstall, of St. Bernard, Ohio, who, with a son, survives him.

Mr. Kirstein was elected an Associate Member of the American Society of Civil Engineers on May 15th, 1917.

ADELBERT PHILO MILLS, Assoc. M. Am. Soc. C. E.*

DIED OCTOBER 20TH, 1918.

Adelbert Philo Mills was born in Tecumseh, Mich., on November 10th, 1883. His parents were Mr. and Mrs. Adelbert Wortman Mills. He was educated in the public schools of Tecumseh, having been graduated from the High School in 1902. He entered the University of Michigan the same year, and was graduated in 1906, with the degree of Bachelor of Science in Civil Engineering; he received the advanced degree of Master of Science in 1909.

From May, 1906, until May, 1907, Mr. Mills was an Assistant Instructor in the University of Michigan, and also Assistant in the office of C. G. Wrentmore, M. Am. Soc. C. E., in Ann Arbor, Mich., for whom he designed, estimated, and inspected the construction of several buildings in Ann Arbor, and a reinforced concrete factory building in Jackson, Mich. He also had field charge of the survey of eighty city lots.

From May, 1907, until October, 1908, Mr. Mills was Assistant Engineer of the American Bottle Company, of Newark, Ohio, and was employed on the construction of new glass plants at Newark, and

* Memoir prepared by E. E. Haskell, M. Am. Soc. C. E.

at Streator, Ill. These plants included a reinforced concrete warehouse and power-house, a large factory building, glass furnaces, gas producers, water, gas, and steam piping, electric wiring, conveying equipment, etc., and, on a large part of this work, he was in responsible charge.

From October, 1908, until October, 1909, Mr. Mills was an Assistant Instructor and took a post-graduate course in the University of Michigan, and then, until June, 1910, was Acting Assistant Professor of Civil Engineering in the College of Civil Engineering of Cornell University. In June, 1910, he was appointed Assistant Professor of Materials at Cornell, which position he held in May, 1918, at the time he received his commission as Captain of Engineers, U. S. Army.

From May to December, 1911, he also had responsible charge of the testing of materials used in the construction of Potter's Falls Dam for developing a new water supply for Ithaca, N. Y.

Professor Mills left Ithaca in May, 1918, and was ordered first to Camp Lee, Va. Later he was transferred to Camp Oglethorpe, Ga., where he remained in training until the latter part of September. He sailed for France on September 29th, and reached there about October 14th, at which time he cabled his family, informing them of his safe arrival. They heard nothing further until November 26th when a message from the War Department announced his death from cerebro-spinal meningitis, in a hospital in Brest, on October 20th, 1918.

Professor Mills is survived by his wife and two children, Elizabeth and Adelbert. Mrs. Mills spent the summer of 1918 with her husband at Camp Oglethorpe, and is at present with her parents in Ypsilanti, Mich.

In the death of Professor Mills, Cornell College of Civil Engineering suffers a serious loss. As a teacher, he stood for lofty ideals and thorough work. His own sense of duty was so high, and his scorn for inaction so great, that he was intolerant of laziness and indifference, so that his classes were animated by an intense spirit of energy.

His personal interest in investigation, fortified by his manual skill in devising and constructing apparatus, as well as by his connection with actual problems of engineering practice, gave advanced students in his Department a field of view and a practical interest that proved of great value educationally and reacted in the greater reputation of the College.

In the Faculty, he was invariably a champion of high standards and good work. Impatient of excuses and intolerant of carelessness, he aimed at the establishment of a greater reputation for the College through the better training of its graduates, and though this attitude sometimes savored of harshness, and though students sometimes complained of the rigor of his requirements, he kept always before himself

his ideal and refused to compromise with inadequate preparation or inferior ability.

Professor Mills' greatest achievement in scholarship was the production of a thoroughly up-to-date book entitled "Materials of Construction," published in 1915. It has been adopted extensively as a textbook by engineering colleges, and as a standard reference work by engineers in practice. It secured his recognition as an authority on this subject.

Professor Mills was elected a Junior of the American Society of Civil Engineers on September 3d, 1907, and an Associate Member on September 3d, 1913.

ALLEN EUGENE NICHOLS, Assoc. M. Am. Soc. C. E.*

DIED MAY 8TH, 1919.

Allen Eugene Nichols, the son of Eugene M. and Ellen M. Nichols, was born at Madison, Wis., on September 30th, 1888. When he was six years old, his parents moved to Philadelphia, Pa., his father being engaged in the engineering and contracting business. His education, however, was obtained mostly in the West.

In 1906, he entered the Civil Engineering Department of Purdue University, Lafayette, Ind., from which he was graduated in 1910. In 1913, he received the degree of Civil Engineer from the same institution.

On his graduation from college, Mr. Nichols entered the employ of the Baltimore and Ohio Railroad Company, with which company he remained until December, 1910, when he resigned to go with R. L. Sackett, M. Am. Soc. C. E., Consulting Engineer for the State of Indiana, as Assistant in the design of water-works and sewage disposal plants. From April, 1911, to May, 1912, Mr. Nichols was employed by the Chicago and Western Indiana Railroad Company as Assistant Engineer on track elevation and maintenance work. From May, 1912, to February, 1914, he was associated with Alvord and Burdick, Consulting Engineers, as Assistant Engineer on the design and construction of sewage disposal and water supply plants.

From February, 1914, to May, 1915, Mr. Nichols was a student at the University of Pennsylvania, where he made a special study of the chemistry of water. From May, 1915, to January, 1918, he was employed as Engineer in direct charge of the design, specifications and contracts for the Bureau of Waste Disposal of the City of Chicago, Ill. During this time, Mr. Nichols made reports for the Department of Public Works on the mechanical and chemical character of garbage tankage produced by the various cities of the United States, and estab-

* Memoir prepared by T. McLean Jasper, Assoc. M. Am. Soc. C. E.

lished a comparison with the standard requirements of the fertilizer trade. He also took charge of the design and specifications for the water purification plant of Oshkosh, Wis.

When the United States entered the war, Mr. Nichols endeavored to enlist in the Army, but owing to a permanent injury, he was not accepted by the military authorities. He, however, entered the employ of the Du Pont Engineering Company, as Engineer of Construction for a 70 000 000-gal. water filtration plant for the Government powder factory at Old Hickory Works, Nashville, Tenn., which position he retained until construction was completed.

On February 1st, 1919, Mr. Nichols, with his father and brother, entered into a general engineering and contracting business. For many years previous he had given special study to the subject of the disposal of sewage and municipal waste and the utilization and reduction of garbage.

"Nick", as he was called by his immediate friends, was one of those quiet, solid fellows, retiring to the casual individual, but to those to whom he gave his friendship, there was no reserve. Those who had enjoyed that friendship miss the man he was and appreciate the richness of the qualities he had shared among them in the relatively short life he lived.

Mr. Nichols died at his home in Chicago, Ill., on May 8th, 1919, after a short illness, of pneumonia, a transfusion of blood to a near relative a few months before his death, having left him with less than normal vitality to fight the disease.

Mr. Nichols was an Associate Member of the American Society of Mechanical Engineers, a Member of the Franklin Institute, and a Member of the American Water-Works Association and the Sons of the American Revolution.

Mr. Nichols was elected an Associate Member of the American Society of Civil Engineers on October 10th, 1916.

DEAN CHASE, Jun. Am. Soc. C. E.*

Died May 26th, 1919.

Dean Chase, the son of Clinton Alden Chase and Sallie Harmon Chase, was born at St. Louis, Mo., on May 5th, 1890. After having been graduated from the McKinley High School, at St. Louis, in 1909, he spent one year in the Engineering Department of the Missouri Pacific Railway. In 1910, he entered the University of Illinois, from which he was graduated in 1914, as a Municipal and Sanitary Engineer, with the degree of B. S.

*Memoir prepared by C. W. Roehrig, Esq., St. Louis, Mo.

After his graduation, Mr. Chase entered the employ of the Water Department of the City of St. Louis, and during parts of 1914 and 1915, was engaged at the Chain of Rocks on the construction of the new filtration plant.

On the completion of this work in the spring of 1915, he concluded to enter the commercial field, and secured a position with the Certainteed Products Corporation as Traveling Salesman, with headquarters at New Orleans, La. Mr. Chase was signally successful in his new endeavor and continued at this work until shortly after the declaration of war with Germany, when he entered the First Officers' Training Camp, at Fort Logan H. Roots, near Little Rock, Ark. After he had been there several weeks, he was rejected for trivial physical defects. Although greatly disappointed, he was undaunted in his zeal to go to his country's aid, and in August, 1917, he enlisted again at New Orleans, and soon thereafter entered the Second Officers' Training Camp, at Fort Winfield Scott, Cal.

On November 27th, 1917, Mr. Chase was commissioned a First Lieutenant in the Coast Artillery Corps, and was assigned to the 62d Regiment, with which he was identified until he was honorably discharged from the service at Camp Custer, Mich., on March 8th, 1919. He saw service with his regiment in France from July 31st, 1918, to February 6th, 1919, but did not get to the front, although the regiment was about to be ordered there when the Armistice was signed. On account of his appointment as Regimental Orienteur, Lieut. Chase became a Staff Officer and was twice recommended for promotion, but, here, again, the signing of the Armistice prevented fulfillment. On May 26th, 1919, the evening of which he met his death, he was commissioned First Lieutenant, Coast Artillery Section, Officers' Reserve Corps of the U. S. Army.

From about March 20th, 1919, to the time of his death on May 26th, 1919, Lieut. Chase was in the employ of the Certainteed Products Corporation as traveling representative, with headquarters at Syracuse, N. Y. On the evening of the fateful day, while motoring near Utica, N. Y., with two prospective customers, they met with an accident, the machine being overturned, and Lieut. Chase was killed instantly. He was buried from the family residence in St. Louis, Mo., on May 30th, 1919, with military honors.

Lieut. Chase possessed an analytical mind and the power of concentration to a high degree, and this was reflected in his student and professional life. He had a most promising career before him, and his untimely taking away will be mourned by a large circle of friends. He had led an honest, upright, and morally clean life, and was loved and respected by all who knew him.

Lieut. Chase was a Member of the Engineers' Club of St. Louis, and was elected a Junior of the American Society of Civil Engineers, on June 3d, 1915.

ERNEST CHARLES DEDICKE, Jun. Am. Soc. C. E.*

DIED JULY 15TH, 1918.

Ernest Charles Dedicke was born on February 19th, 1889, in the village of Dolgeville, Herkimer County, N. Y. His early childhood days were spent in the place of his birth, and it was here that he received most of his grammer school education. At the age of twelve, he moved with his family to Hamburg, Germany, where he remained until 1905, and where he completed his high school education.

On his return to the United States, the young lad, led by the same adventurous spirit that brought him back to his native shores, and prompted by a rare love of country which had become the more pronounced during his stay on foreign soil, joined the United States Army. He was assigned to the 11th U. S. Cavalry, and, with that regiment, took part in the campaign of Cuban Pacification, in 1906-08. He was honorably discharged in 1908, having reached the grade of Sergeant, which, in the old army, was a rare achievement for one of his years.

Mr. Dedicke returned to the States and took up the study of expert accountancy at Valparaiso University. While employed as Assistant at the Remington Works, at Ilion, N. Y., his health failed, and he was compelled to turn to the life of the great outdoors. His choice fell on the Engineering Profession. While gathering practical knowledge, he acted as Foreman on the construction of a large dam at Dallas, Tex., also on another at Hinkley, N. Y., and was connected with several highway improvement contracts in various parts of New York State. Besides thus gaining practical experience, he was diligently studying with the American School of Correspondence. In 1913, Mr. Dedicke was appointed Junior Engineer under the Civil Service System of the City of New York, and was employed on the construction of the New York City Subways. In 1914, he was transferred to the Utica Office of the New York State Highway Department, where he remained until he once more joined the colors. This was at the time of the Mexican trouble.

He enlisted in Troop G, of the 1st New York Cavalry, at Utica, N. Y., with which he saw service on the Mexican border until the early spring of 1917. He then received a commission as Second Lieutenant of Engineers, and was ordered to Madison Barracks, N. Y., for training. Three months later, he was assigned to the 6th U. S. Engineers, at Washington Barracks, D. C., and with that regiment left for France in November, 1917. This outfit did splendid work as an independent unit with the British Army. Company D, of which Lieut. Dedicke was First Lieutenant, was decorated for bravery by the British Government, for heroic work with the now famous emergency army of

* Memoir prepared by O. J. Dempster, M. Am. Soc. C. E.

Gen. Carey, which army held back the German advance in March, 1918, until reinforcements arrived. In April, the 6th Engineers were assigned to the Third Division, and with the Second Division won immortal fame at Chateau Thierry, in June and July, 1918. In July, Lieut. Dedicke was assigned as Engineer Officer with the 4th U. S. Infantry, and as such had charge of all trench work and barbed wire entanglements.

It was while directing the construction of these works, 5 km. east of the now famous French town of Chateau Thierry, and during the early morning German barrage of July 15th, 1918, that Lieut. Dedicke was mortally wounded by shrapnel, dying at 5 o'clock that afternoon, in Field Hospital No. 27.

He was beloved by his men and respected by his superiors, and was a finely trained engineering officer. He is sleeping the eternal sleep among his fellow heroes in Cemetery No. 284, near the spot where the ambitions of the Hun were stayed.

Lieut. Dedicke was elected a Junior of the American Society of Civil Engineers on November 28th, 1916.

PAPERS AND DISCUSSIONS CURRENT IN PROCEEDINGS

"Cement Joints for Cast-Iron Water Mains." CLARK H. SHAW.....Mar., 1917
Discussion.....May, Aug., "

Final Report of the Special Committee on Steel Columns and Struts.....Dec., "
Discussion.....Feb., Mar., Apr., Aug., Oct., 1918

"Verification of the Bazin Weir Formula by Hydro-Chemical Gaugings."
FLOYD A. NAGLER.....Jan., "
Discussion.....Mar., May, Aug., Nov., "

"Construction Methods Used in Building the Lower Reservoir Dam of the Balmorhea Project." VERNON L. SULLIVAN.....Apr., "

"Emergency Construction Work Due to War Conditions, With Especial Reference to the Construction Division of the Army." GEORGE W. FULLER.....May, "

"The National Railroad Question of To-Day." FRANCIS LEE STUART.....Feb., 1919
Discussion.....Mar., Apr., May, "

"On a New Principle in the Theory of Structures." GEORGE F. SWAIN.....Mar., "
Discussion.....May, Aug., Sept., "

"The East Canyon Creek Dam." A. F. PARKER.....Mar., "
Discussion.....May, Aug., Sept., "

"Pressures in Penstocks Caused by the Gradual Closing of Turbine Gates."
NORMAN R. GIBSON.....Apr., "
Discussion.....May, Aug., "

"Sewage and Wastes Disposal for the United States Army." LEONARD S. DOTEN.....May, "
Discussion.....Aug., Sept.,

The Proposed New York and New Jersey Vehicular Tunnel: An Informal Discussion.....May, Aug., "

American Highways: An Informal Discussion.....May, Aug., "

"Water Supply for the Camps, Cantonments and Other Projects Built by the Construction Division of the United States Army." DABNEY H. MAURY.....Aug., "
Discussion.....Sept., "

"Contracts—A Comparison of 'Cost Plus' with Other Forms." ERNEST WILDER CLARKE.....Aug., "

"Physiography of Water-Sheds and Channels, and Analysis of Stream Action of Southern California Rivers, with Reference to the Problems of Flood Control." A. L. SONDEREGGER. (To be presented October 1st, 1919.).....Aug., "

"Comprehensive Plotting of Water Turbine Characteristics." KARL R. KENNISON.....Aug., "

"The Silt Problem of the Zuni Reservoir." H. F. ROBINSON.....Aug., "

"The Accuracy of Water Level Recorders and Indicators of the Float Type."
J. C. STEVENS.....Aug., "

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OF THE

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OF

CIVIL ENGINEERS

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(INSTITUTED 1852)

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CONTENTS

Society Affairs ..... Pages 867 to 1058.
Papers and Discussions ..... Pages 713 to 948.

NEW YORK 1919

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ON THE REGULATION OF WATER RIGHTS: F. H. Newell, W. C. Hoad, John H. Lewis.

TO REPORT ON STRESSES IN RAILROAD TRACK: A. N. Talbot, A. S. Baldwin, G. H. Bremner, John Brunner, W. J. Burton, Charles S. Churchill, W. C. Cushing, W. M. Dawley, Robert W. Hunt, J. B. Jenkins, George W. Kittredge, Paul M. LaBach, C. G. E. Larsson, G. J. Ray, Albert F. Reichmann, H. R. Safford, F. E. Turneaure, J. E. Willoughby.

The Reading Room of the Society is open from 9 A. M. to 10 P. M. every day, except Sundays, New Year's Day, Fourth of July, Labor Day, Thanksgiving Day, and Christmas Day; during July and August, it is closed at 6 P. M.

HEADQUARTERS OF THE SOCIETY—33 WEST THIRTY-NINTH STREET, NEW YORK.

TELEPHONE NUMBER.....4600 Vanderbilt.
CABLE ADDRESS.....“Ceas, New York.”

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AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PROCEEDINGS

This Society is not responsible for any statement made or opinion expressed in its publications.

SOCIETY AFFAIRS

CONTENTS

	PAGE
Minutes of Meetings:	
Of the Society, September 17th, October 1st, October 15th, November 5th, November 19th, and December 3d, 1919	867
Of the Board of Direction, September 9th, October 14th, and November 25th, 1919.	883
Report of the Committee on Development. (With Correspondence.)	889
Items of Interest	926
Announcements:	
Hours during which the Reading Room is open	972
Future Meetings	972
Annual Meeting	972
List of Nominees for Offices to be Filled at the Annual Election, January 21st, 1920.	972
National Service Committee of Engineering Council	973
How to Make Remittances to the Society	973
Roll of Honor	973
Engineering Societies Employment Bureau	973
Searches in the Library	974
Papers and Discussions	974
Local Associations of Members of the American Society of Civil Engineers	974
Privileges of Engineering Societies Extended to Members	991
New Books	992
Membership (Additions, Reinstatements, Resignations, Deaths)	1001
Recent Engineering Articles of Interest	1021

MINUTES OF MEETINGS OF THE SOCIETY

September 17th, 1919.—The meeting was called to order at 8.30 P. M.; Vice-President Nelson P. Lewis in the chair; Chas. Warren Hunt, Secretary; and present, also, 136 members and guests.

The meeting was devoted to a discussion on "The Need for a National Department of Public Works". George W. Fuller, M. Am. Soc. C. E., Chairman, Campaign Committee for the Eastern District of New York of the Engineers', Architects', and Contractors' Conference on National Public Works, opened the discussion. The subject was also discussed by Walter D. Blair, M. Am. Inst. of Architects, Maj. C. T. Chenery, representing the National Service Committee of Engineering

*Owing to the printers' strike, *Proceedings* were not issued for October and November. This number, therefore, covers the last three months of 1919.

Council, and F. J. MacIsaac, Past-President of the General Contractors' Association, and by Messrs. John A. Bensel, A. B. Fry, R. D. Black, Alfred D. Flinn, and H. F. Dunham.

The Secretary announced the election of the following candidates on September 9th, 1919:

As Members

Warren Hammond Barnes, San Francisco, Cal.
René Leon Bertin, New York City
James Eustace Blackwell, Seattle, Wash.
Drury Butler, Sacramento, Cal.
August Ewaldt Christhilf, Baltimore, Md.
Clyde Maxwell Cram, Los Angeles, Cal.
Elbert Hermon Dresser, Duluth, Minn.
William Stuart Fallis, Raleigh, N. C.
Frank Lee Gorman, Cleveland, Ohio
William Louis Lancaster, Spartanburg, S. C.
Myron George Littlefield, Pottstown, Pa.
Henry Howell Lotter, Omaha, Nebr.
William Sherman Lozier, Rochester, N. Y.
Torata Matsumoto, Keelung, Formosa, Japan
Harry Artus Metcalfe, Birmingham, Ala.
David William Morrow, Cleveland, Ohio
Sidney Howard Osborne, Kansas City, Mo.
Locke McIndoe Perkins, St. Paul, Minn.
Francis Amory Pope, Duluth, Minn.
Edmund Astley Prentis, Jr., New York City
Allan Townshend Ricketts, Maplewood, N. J.
William Hampden Sage, Jr., A. E. F., Lieser, Germany
John Martin Sullivan, New Haven, Conn.
George Francis Donnell Trask, Washington, D. C.
John Henry Tufel, Cleveland, Ohio
Horatio Phillips Van Cleve, Princeton, N. J.
Robert John Weir, Seward, Alaska
Louis Yager, St. Paul, Minn.

As Associate Members

Albert Worthington Atwater, Cleveland, Ohio
Sylvester Clay Baker, East St. Louis, Ill.
William Dartis Baker, Philadelphia, Pa.
Robert William Bame, Cincinnati, Ohio
Edgar Earl Barker, Morococha, Peru
Leo Harry Bernstein, New York City
Harry Andrew Betaque, San Diego, Cal.
Don William Bingham, Flint, Mich.

Joel Hoffman Black, Shanghai, China
George Fred Brockman, Louisville, Ky.
Henry Bucher, Pittsburgh, Pa.
Charles Roland Burdette, Baltimore, Md.
Thomas Franklin Chace, Berkeley, Cal.
Robert Leroy Cochran, Lincoln, Nebr.
James Leslie Coombes, Lynch Mines, Ky.
Harry Edmond Cotton, Omaha, Nebr.
Horace Wilkinson Coulson, South Shields, England
John Sterling Deans, Jr., Buffalo, N. Y.
Ralph Avard Doane, Boston, Mass.
Edward Louis Edes, Oakland, Cal.
George Georgsson Ehrenborg, Louisville, Ky.
David Leonard Erickson, Lincoln, Nebr.
Martin Cyral Erwin, San Antonio, Tex.
Frank Fairchild Fergusson, London, England
Robert Seymour Fiske, Philadelphia, Pa.
James Henry Fitzgerald, Jersey City, N. J.
Michael Augustin Fouhy, Philadelphia, Pa.
Edwin Philip Fox, Pittsburgh, Pa.
Ernest Franz Fox, Jr., Brooklyn, N. Y.
Harry Wallis Gochnauer, Columbus, Ohio
Irving Gottheim, Seattle, Wash.
Dale Janverin Graham, Butler, Pa.
Maurice Brown Greenough, Cleveland, Ohio
Sytze Elo Greydanus, Paterson, N. J.
Luis Alejandre Guevara i Morales, Trujillo, Peru
George Conrad Habicht, Pittsburgh, Pa.
Carl William Haefner, South Boston, Mass.
John Wendell Hall, Mazeppa, Minn.
Andrew Broadus Hargis, Camp McClellan, Ala.
Wesley Lawrence Henry, New York City
Carl Joseph Jacobson, Pittsburgh, Pa.
Ernest Douglas Kahlert, Wilmington, Del.
Harry Joseph Kelly, Port Arthur, Tex.
Lester Holcomb Lacy, Mobile, Ala.
William Herbert Lange, New Rochelle, N. Y.
Simon Hammett Leister, Philadelphia, Pa.
Horace Greeley Leng, Philadelphia, Pa.
John Grover Little, Leonia, N. J.
Frank Albert MacSheffray, Boston, Mass.
Adam Arthur McLintock, Ocean Island, Central Pacific
Charles Michael Madden, West Kill, N. Y.
William Aitken Miller, Sydney, N. S. W., Australia
Eldon Wright Moreland, Portland, Ore.

Herbert Lincoln Nagel, Akron, Ohio
Harry Edmund Newell, New York City
Alfred Chandler North, Los Angeles, Cal.
Israel Orlian, Philadelphia, Pa.
Harvey Skidmore Owen, St. Louis, Mo.
Roscoe Owen, Springfield, Mo.
William Joseph Provaznik, Omaha, Nebr.
Otto Coffeen Fitz Randolph, Cleveland, Ohio
David Hubbard Redinger, Kernville, Cal.
George Sadtler Robertson, Baltimore, Md.
Ernest Leffert Robinson, Lowell, Mass.
David Alfred Sealey, New York City
Ralph Lawrence Silver, Basin, Wyo.
Fred Washburn Simonds, Elizabeth City, N. C.
Benjamin LeCompte Smith, Baltimore, Md.
Cedric Burnett Smith, Pittsburgh, Pa.
James Axtell Smith, Brooklyn, N. Y.
Orville Heber Taylor, Chicago, Ill.
Valentine Vasilievich Tchikoff, New York City
Francis Joseph Von Zuben, Fort Worth, Tex.
Richard Emil Wachter, St. Louis, Mo.
Jacob Charles Wagen, Lake Worth, Fla.
Henry Lincoln Wilder, Lebanon, Pa.
Francis Douglas Wilson, Detroit, Mich.
Carl Wilbur Wood, Philadelphia, Pa.
Albert Edward Wynn, Syracuse, N. Y.
Harold George Wynne, New Haven, Conn.

As Associate

Albert Taylor Rhodes, Boston, Mass.

As Juniors

Victor Franklin Anderson, San Francisco, Cal.
Frank Palmer Arnold, Charleston, W. Va.
Leopold Lyon Balleisen, Brooklyn, N. Y.
Alban Francis Butler, Akron, Ohio
John Belford Cleary, Casper, Wyo.
William Junkin Cox, Am. Exp. Forces, France
Evangelos John Critzas, New York City
Willard Farnsworth Day, Lynchburg, Va.
Arthur Charles Eberhard, Washington, D. C.
Ernest Shengtsu Hsieh, Troy, N. Y.
Charles West Jones, San Francisco, Cal.
William Joseph Kupec, New York City

Toshiyuki Okubo, New York City
Aubrey Eugene Perry, Pendleton, Ore.
Phillips Branch Tartt, Terrell, Tex.
Charles William Van Dyke, New York City

The Secretary announced the transfer of the following candidates on September 9th, 1919:

From Associate Member to Member

Augustus Rowley Archer, New York City
Carl August Bock, Dayton, Ohio
Roger Derby Black, New York City
Rodman Merritt Brown, Omaha, Nebr.
Eugene Dickinson Burnell, New York City
James Edward Cahill, Chicago, Ill.
Clarke Copeland Cottrell, Carson City, Nev.
Vernon Royce Covell, Pittsburgh, Pa.
Frederick N. Cronholm, Andrade, Cal.
William Henry Dittoe, Columbus, Ohio
Elijah Herbert Dunmire, Kansas City, Mo.
John North Edy, Helena, Mont.
Chester Centennial Fisher, Boise, Idaho
Milton Harvey Freeman, Valhalla, N. Y.
Edward James Fucik, Chicago, Ill.
Henry Haydock Garrigues, Philadelphia, Pa.
John Owen Greenway, Yakima, Wash.
Walter John Kackley, Nashville, Tenn.
Edward Allen Keys, Am. Exp. Forces, France
Ernest Avery Lamb, Little Falls, N. Y.
Byron James Lambert, Iowa City, Iowa.
Conrado Eugenio Martinez y Rengifo, Havana, Cuba
Walter Edward Miller, Madison, Wis.
Arthur Edmund Owen, Montclair, N. J.
Melvin S. Rich, Washington, D. C.
Ross Milton Riegel, Dayton, Ohio
Nathan Herbert Sanderson, Boston, Mass.
Maurice Roos Scharff, Pittsburgh, Pa.
Maxwell Waide Smith, Camp A. A. Humphreys, Va.
Milton Frederick Stein, Chicago, Ill.
James Cummin Stevenson, Chicago, Ill.
Starr Truscott, Washington, D. C.
Walter Owen Washington, Lockhart, Tex.
Rudolph James Wig, Philadelphia, Pa.
Benjamin Russell Wood, Am. Exp. Forces, France.

FROM JUNIOR TO ASSOCIATE MEMBER

EARL DANIEL BROWN, San Francisco, Cal.
JOHN TOWNSHEND CHILD, Rochester, N. Y.
EARL HARRY COLLINS, Sault Ste. Marie, Mich.
ARTHUR FRANCIS DEJONGH, Santiago de Cuba, Cuba
WALTER EDGAR JESSUP, Pasadena, Cal.
HENRY MALCOLM PRIEST, Dayton, Ohio
RALPH SMILLIE, U. S. S. *Massachusetts*
WALTER STEINBRUCH, Brooklyn, N. Y.
HENRY FRIEZE VAUGHAN, Detroit, Mich.
FREDERICK HOLMAN WARING, Columbus, Ohio

The Secretary announced the following deaths:

CHARLES TITUS CHURCH, of Geneva, N. Y., elected Member, May 1st, 1889; died August 25th, 1919.

CHARLES MATTATHIAS JACOBS, of London, England, elected Member, May 4th, 1904; died September 7th, 1919.

Adjourned.

October 1st, 1919.—The meeting was called to order at 8.30 P. M.; President F. S. Curtis in the chair; Charles Warren Hunt, Secretary; and present, also, 49 members and guests.

The minutes of the meeting of September 3d, 1919, were approved as printed in *Proceedings* for September, 1919.

A paper by A. L. Sonderegger, M. Am. Soc. C. E., entitled "Physiography of Water-Sheds and Channels, and Analysis of Stream Action of Southern California Rivers, with Reference to the Problems of Flood Control", was presented by the Secretary, and the subject was discussed by Messrs. T. Kennard Thomson, Charles A. Pohl, Francis H. Wright, F. S. Curtis, and H. F. Dunham.

The Secretary announced that, owing to labor trouble in the printing trade, the issue of the October, 1919, *Proceedings,* might be delayed for some time.

The Secretary announced the following deaths:

CHESTER BIRGE DAVIS, of Magnolia, Del., elected Member, February 1st, 1882; died September 16th, 1919.

GEORGE CLARK MILLS, of Cincinnati, Ohio, elected Member, June 4th, 1913; died August 13th, 1919.

HUGH MONROE WILSON, of New York City, elected Associate, December 3d, 1913; died September 19th, 1919.

Adjourned.

October 15th, 1919.—The meeting was called to order at 8.30 P. M.; President F. S. Curtis in the chair; Chas. Warren Hunt, Secretary; and present, also, 155 members and guests.

The topic for discussion at this meeting was "The Relation of the Engineer to the Future Military Activities of the United States." The discussion was opened by George D. Snyder, M. Am. Soc. C. E., who was followed by Maj.-Gen. William Murray Black, Maj.-Gen. W. C. Langfitt, Brig.-Gen. R. C. Marshall, and Col. Edward Burr, all of the United States Army, and Messrs. William Barclay Parsons, R. D. Coombs, F. A. Snyder, E. F. Robinson, and A. W. Robinson.

The following resolution, proposed by A. R. Archer, M. Am. Soc. C. E., and seconded by Frederic Molitor, M. Am. Soc. C. E., was adopted by the meeting:

"Resolved: That it is the sense of this meeting that Engineering Council should take the necessary steps to formulate a comprehensive series of recommendations to be presented to Congress in connection with the subject-matter of the discussion of this evening."

The Secretary announced the election of the following candidates on October 14th, 1919:

As Members

Frank Laughton Black, Bridgeport, Conn.
Thomas Brogden Blackburn, Los Angeles, Cal.
Bernard Blum, St. Paul, Minn.
Edward Clarke Buck, Georgetown, British Guiana
Edward North Chisolm, Jr., Washington, D. C.
Frank Ezekiel Cudworth, Brooklyn, N. Y.
Edward Brinton Darlington, Jerome, Idaho
Clarkson Alcott Disbrow, New York City
William Smith Downs, Morgantown, W. Va.
Thomas Edward Forrest, Portland, Me.
Frederick William Henrici, Pittsburgh, Pa.
Laurence Ilsley Hewes, Portland, Ore.
James Granbery Jackson, Nashville, Tenn.
Thomas Hitchcock Joy, Chicago, Ill.
Olaf Ingvald Knoph, Christiania, Norway
James Henry Knowles, San Francisco, Cal.
Ludwig Theodore Maenner, St. Louis, Mo.
Tojiro Sano, Kobe, Japan
Edward Hugh Schulz, Milwaukee, Wis.
Frederic Jackson Taylor, Livingston, Mont.
James Marshall Vest, Dehue, W. Va.
George Espy Vinnedge, Fort Worth, Tex.
Milton James Whitson, Washington, D. C.
John Huw Williams, Hankow, China.

As Associate Members

Harland Bartholomew, St. Louis, Mo.
Stanley Elgin Clinton Behneman, San Francisco, Cal.

Harold Sill Bell, Elizabeth, N. J.
James Schenck Bowman, Clearmont, Wyo.
Wendell Morris Butts, San Francisco, Cal.
William Joseph Carrel, Lexington, Ky.
Harry Young Carson, Birmingham, Ala.
Ray Norman Case, Ashtabula, Ohio
Charles Cadwallader Cassel, Watertown, N. Y.
Luther Chittenden Conant, Mauch Chunk, Pa.
Harry Lester Conrad, Lansing, Mich.
William Aloysius Courtenay, Jr., Chester, Pa.
David Jesse Cox, Pueblo, Colo.
Robert Hall Craig, Harrisburg, Pa.
Charles James Craigmile, Midvale, N. J.
James Joseph Doland, Nitro, W. Va.
William Edward Dougher, Webster Springs, W. Va.
Francis Wheelock Du Bois, Highland Park, Mich.
Samuel Eckels, Pittsburgh, Pa.
Herbert Charles Elton, New Haven, Conn.
Leo Matthew Geraghty, Williamsport, Pa.
Herbert Thurston Gerrish, Boston, Mass.
Carl Martin Geupel, Syracuse, N. Y.
Henry Jacob Grathwol, Parkersburg, W. Va.
Edwin Dwight Allemand Gray, Toronto, Ont., Canada
Michael Halpern, Long Island City, N. Y.
Arthur John Hart, Sydney, New South Wales, Australia
William Wren Hay, Forest Hills, N. Y.
Homer Wynne Hesterly, Tampa, Fla.
James Allan Higgs, Jr., Atlanta, Ga.
Francis Vincent Hogan, Albany, N. Y.
Arthur Francis Holland, Providence, R. I.
Alpha Harney Kindrick, Okmulgee, Okla.
Walter Jacob King, Oswego, Kans.
Louis Alfred Jenny, Dumont, N. J.
Lionel Montefiore Levine, New York City
Henry Gay Livesay, Louisville, Ky.
Homer Bailey Livingston, San Benito, Tex.
Warren Adams Lyon, Camp A. A. Humphreys, Va.
Arthur Siverine Mannes, Mobridge, S. Dak.
Bergen Stelle Merrill, New Orleans, La.
John Thomas Mockler, Buffalo, N. Y.
James Gates Moore, Daytona, Fla.
Adelbert James Newman, Long Beach, Cal.
Harry Stillwell Nixon, Omaha, Nebr.
Emil August Nordstrom, Wilmington, Del.
Joseph Pugh, Augusta, Ga.

Frank Victor Ragsdale, Memphis, Tenn.
Chatham Coffee Reams, Memphis, Tenn.
George Norman Robinson, Newark, N. J.
Felix King Roullard, Butte, Mont.
Harry Kelley Rubey, Pittsburgh, Pa.
Guy Woodford Sackett, Charleston, S. C.
George Henry Siems, Charleston, W. Va.
Julian Polk Smith, Birmingham, Ala.
Frederick Charles Stauffen, Baltimore, Md.
Leonard Jackson Stevens, Chicago, Ill.
William Henry Stewart, Dugger, Ind.
Earle James Trimble, Muscle Shoals, Ala.
Ping Ye Tsai, Peking, China
Moses Allyn Wadhams, Springfield, Mass.
Philip Bangs Walker, Needham, Mass.
John Aloysius White, Allentown, Pa.
Charles Earl Whiteney, Boston, Mass.
Eugene North Wood, Tulsa, Okla.

As Associates

Alan Hawes Critcher, San Francisco, Cal.
Edward Alfred Simmons, New York City

As Juniors

Bjarne Bergsland Anderson, Brooklyn, N. Y.
Joseph Paul Blundon, Charleston, W. Va.
John Neil Bohannon, Atlanta, Ga.
Andrew Thomas Bower, Hog Island, Pa.
George Herman Buck, Clinchfield, Va.
Clyde Stanley Constant, Jonesboro, Ark.
William Corman, St. Louis, Mo.
Philip Nahm Cristal, Camp A. A. Humphreys, Va.
John James Hartman, New York City
Frank Bowman Hastie, Camp A. A. Humphreys, Va.
Carl Adam Hechmer, Baltimore, Md.
Ross Waldron McKinstry, Pittsburgh, Pa.
Leslie Edward Pierce, Dayton, Ohio
Svend Munk Plum, Youngstown, Ohio
William Laurie Seamen, Boston, Mass.
Elmer Byron Shupe, Carlisle, Pa.
Oswald Speir, Jr., Fresno, Cal.
Harry David Stockwell, Sewell, Chile
Samuel Hyde Thompson, Cascade Locks, Ore.
Wayne Edward Timmerman, Massena, N. Y.
Joseph Jones Twitty, Camp A. A. Humphreys, Va.

Anthony George Voska, Chanute, Kans.
Malcolm Walsh, Tompkinsville, N. Y.
Nai-Zung Zee, Shanghai, China

The Secretary announced the transfer of the following candidates on October 14th and 15th, 1919:

From Associate Member to Member

Harry Walton Bell, Mobile, Ala.
Hans Berents, New York City
Ernest Delevan Cole, Bartlesville, Okla.
William Nelson Carey, St. Paul, Minn.
Frederic Lucius Copeland, Mason City, Ill.
Frank Hill Davis, Little Rock, Ark.
Louis Rapp Ferguson, Wilmington, N. C.
Thomas Lilly Fountain, Am. Exp. Forces, France
Ralph Hamlin, Minneapolis, Minn.
Sidney Twichell Harding, Berkeley, Cal.
Christian Peter Jensen, Fresno, Cal.
Lewis Allen Jones, Montgomery, Ala.
Ralph Briggs Kyle, New Orleans, La.
Mark Linenthal, Wilmington, N. C.
Thomas Maddock, Phœnix, Ariz.
Manley Osgood, Detroit, Mich.
John Endicott Porter, Yonkers, N. Y.
William Jenner Powell, Dallas, Tex.
Henry George Reitz, West Park, Ohio.
Julian Richmond, Yonkers, N. Y.
Henry Casper Tammen, Kansas City, Mo.
Charles Dura Thomas, Marlborough, Mass.
John Robert Wilbanks, Columbus, Ohio
Everitt Wyche Wilson, Asheville, N. C.

From Junior to Associate Member

John Goodin Bailhache, San Francisco, Cal.
Henry Wilfrid Barnes, Guayaquil, Ecuador
George Allyne Belden, Savannah, Ga.
Bernard Joseph Bleistein, Brooklyn, N. Y.
Donald Gladstone Coombs, Rancagua, Chile
Edwin Arthur Dow, Worcester, Mass.
Charles Sumner Heidel, Helena, Mont.
William Joseph Heiser, Brooklyn, N. Y.
Lawrence Wilson Kinnear, Detroit, Mich.
Claude Alfred Latimer, Elizabeth, N. J.
Harry Douglas Lovering, St. Paul, Minn.

Stanley McCassy, Chicago, Ill.
Oscar William Melin, Cincinnati, Ohio
Thomas Charles Morgan, Brooklyn, N. Y.
Harvey Timlow Munn, Washington, D. C.
Blair Arthur Ross, Washington, D. C.
Donald Hefley Rowe, Portland, Ore.
Walter Clifford Sadler, Seattle, Wash.
Herschel C. Smith, Oklahoma City, Okla.
John George Stupp, St. Louis, Mo.
John Croswell Warkley, Cooper, Wyo.
Lee Hoomes Williamson, New York City

The Secretary announced the following deaths:

Archibald Smith Frew, of Sydney, New South Wales, Australia, elected Member, October 3d, 1900; date of death unknown.

John Vose Hazen, of Hanover, N. H., elected Associate, June 5th, 1889; Member, May 2d, 1911; died October 2d, 1919.

Adjourned.

November 5th, 1919.—The meeting was called to order at 8.30 P. M.; Past-President George H. Pegram in the chair; Chas. Warren Hunt, Secretary; and present, also, 320 members and guests.

The meeting was devoted to a discussion on "The Compensation of Engineers", and members of the other Founder Societies were invited to attend.

The subject was presented by Arthur S. Tuttle, M. Am. Soc. C. E., Chairman of Engineering Council's General Committee, and of the State and Municipal Section, who was followed by Francis Lee Stuart, M. Am. Soc. C. E., Chairman of the Railroad Section. In the absence of John C. Hoyt, M. Am. Soc. C. E., Chairman of the Federal Section, John S. Conway, M. Am. Soc. C. E., spoke for that Section, illustrating his remarks with lantern slides. A general discussion followed, in which Messrs. L. D. Rights, George M. Purver, Chas. Warren Hunt, O. C. Merrill, William W. Brush, and C. D. Thomas took part.

The Secretary announced the following deaths:

Walter Hayden Graves, of San Francisco, Cal., elected Member, February 2d, 1909; died September 26th, 1919.

Thomas William Jaycox, of Denver, Colo., elected Member, January 4th, 1882; died September 8th, 1919.

Irving Sparrow Wood, of Providence, R. I., elected Junior, March 5th, 1890; Associate Member, March 7th, 1900; Member, March 6th, 1906; died October 20th, 1919.

Adjourned.

November 19th, 1919.—The meeting was called to order at 8.30 P.M.; Vice-President Nelson P. Lewis in the chair; Chas. Warren Hunt, Secretary; and present, also, 272 members and guests.

The subject for the evening was "The Proposed Nationalization of Railroads in the United States." The discussion was opened by Col. W. J. Wilgus, M. Am. Soc. C. E., who was followed by Ivy L. Lee, formerly Executive Assistant to the President of the Pennsylvania Railroad Company. The subject was also discussed by Messrs. Frederic Molitor, B. H. Bryant, Charles Hansel, W. G. Besler, and W. L. Waters.

The Secretary read the following letter:

"Washington, D. C., October 29, 1919.

"MR. CHARLES WARREN HUNT, *Secretary,*
"American Society of Civil Engineers,
"33 West 39th Street, New York, N. Y.

"DEAR SIR.—Your letter of October 27th received and contents noted. You extend to me an invitation to address the meeting of your society on November 19th, 1919, at 8.30 P. M., and you say that the subject for discussion will be the proposed 'Nationalization of Railroads'.

"Permit me to advise you in reply that the Executive Council of the American Federation of Labor now has this entire subject under consideration. Until the Executive Council has formulated and declared its policy I am sure you will agree with me that it will not be advisable for me to undertake to discuss the subject and for the same reasons it will not be possible for me to accept your invitation to address the meeting of your society or to designate any other representatives of the American Federation of Labor to speak for me.

"Very truly yours,
"SAMUEL GOMPERS,
"President, American Federation of Labor."

The Secretary announced the following deaths:

PERCY HERBERT ASHMEAD, of New York City, elected Member, March 6th, 1907; died November 11th, 1919.

HENRY MANLEY, of West Roxbury, Mass., elected Member, June 2d, 1880; died October 28th, 1919.

CARL REDLICH, of Vienna, Austria, elected Member, September 7th, 1904; date of death unknown.

Adjourned.

December 3d, 1919.— The meeting was called to order at 8.30 P. M.; Past-President George H. Pegram in the chair; Chas. Warren Hunt, Secretary; and present, also, 170 members and guests.

The meeting was devoted to a discussion of the Report of the Committee on Development, in which the following members took part: Messrs. Paul G. Brown, Charles Hansel, Daniel Bontecou, Frederick

C. Noble, Francis Lee Stuart, George H. Pegram, Chas. Warren Hunt, D. L. Turner, E. J. Mehren, Charles S. Bilyeu, L. L. Tribus, E. W. Stern, Lewis D. Rights, S. N. Castle, W. T. Chevalier, William W. Brush, H. C. Keith, A. B. Fry, J. M. Goodell, and Frederic A. Snyder.

The Secretary announced the election of the following candidates on November 25th, 1919:

As Members

Horace Leland Bushnell, Seattle, Wash.
Denzil Worrell Coe, Elmhurst, N. Y.
Vladimir Goriachkovsky, New York City
Joseph William Hershey, Pittsburgh, Pa.
John Robert Hicks, Gary, W. Va.
Bert Bradley Hodgman, New York City
Carey Vandervort Hodgson, Washington, D. C.
Thomas Henry Hogg, Toronto, Ont., Canada
Leon Lynwood Holland, Saunderstown, R. I.
Ford Kurtz, Muscle Shoals, Ala.
Gustave Rudolf Lukesh, Charleston, S. C.
John MacMillan, Los Angeles, Cal.
Thomas Carlyle Morris, Balboa Heights, Canal Zone, Panama
James Norman Pease, Atlanta, Ga.

As Associate Members

Irvin Henry Althouse, Porterville, Cal.
William John Ash, New York City
Howard Fink Bachman, Bethlehem, Pa.
Warren Gammell Baxter, Providence, R. I.
Garner Arthur Beckett, Alameda, Cal.
Hubert Dickson Bowman, New York City
Arthur Dudley Buzby, Upper Montclair, N. J.
Robert Bruce Carruthers, San Antonio, Tex.
Walter Marion Coffey, Mill Valley, Cal.
Arthur Burr Collins, Yakima, Wash.
Claude Artist Combs, Caney, Kans.
Norman Homer Cooke, Wilmington, Del.
William Clarence Cross, New York City
Irving Demarest, Madison, N. J.
Clarence Joseph Duby, Youngstown, Ohio
Harry Jacob Finebaum, Philadelphia, Pa.
Ralph Justin Fogg, Bethlehem, Pa.
John Eaton Fontaine, Memphis, Tenn.
Howard Elmer Gage, Cleveland, Ohio
Eldon Addison Garland, Santa Barbara, Cal.
Harry Jocelyn Goodale, Attleboro, Mass.

Bernard Elbert Gray, Charleston, W. Va.
Roy Melvin Green, College Station, Tex.
Donald Leal Greenleaf, South Clinchfield, Va.
Donald Armstrong Hannaman, Salisbury, Md.
William Hannum, Christiana, Pa.
William Jackson, Pittsburgh, Pa.
John Lester Jewell, New York City
Frank Arthur Johnson, Berkeley, Cal.
Alfred Jones, Los Angeles, Cal.
Owen Robert Jones, South Bethlehem, Pa.
Frank Burdette Kiel, Little Rock, Ark.
Frank Elmer King, Newark, N. J.
Alexander Clinton Knight, Baltimore, Md.
Robert Maurice Knox, Blue Island, Ill.
Henry Hugo Kranz, Dallas, Tex.
Fritz Kubitz, Pittsburgh, Pa.
Joseph Clinton Letts, East View, N. Y.
Justin Charles McCarthy, New York City
Jerome Francis Joseph McGehearty, Fort Worth, Tex.
Axel Osvald Malvig, Brooklyn, N. Y.
Walter Scott Miller, Parkland, Pa.
Richard Austin Myers, Atlanta, Ga.
Marvin Young Neely, Philadelphia, Pa.
Emit Coin Nickey, Poplar Bluff, Mo.
Alfred Adolph Noetzli, San Francisco, Cal.
William James Norris, Portland, Ore.
Newell Hamilton Orr, Pittsburgh, Pa.
John Edwin Perry, Ithaca, N. Y.
John March Phillips, Boonton, N. J.
Theodore Arthur Polansky, Parkersburg, W. Va.
Robert Henry Randall, Akron, Ohio.
Charles Henry Reynolds, Fort Dodge, Iowa
Jesse Rosenwald, San Francisco, Cal.
William Claiborne Ross, Hazen, Ark.
Oscar Adolph Sandquist, Akron, Ohio
Wallace Atterbury Sawdon, Laurel, Miss.
William Charles Schnabel, Baltimore, Md.
Jacob Shlessinger, Baltimore, Md.
Velentine Bernard Siems, Baltimore, Md.
Hilmar Frederick Smith, Florence, Ala.
Stanley Smith, Philadelphia, Pa.
William Howard Spear, Los Angeles, Cal.
William Speed, Louisville, Ky.
William Macy Stanton, Lansdowne, Pa.

Charles Robert Strattman, Bartlesville, Okla.
Maurice Toby, New York City
Darwin Wadsworth Townsend, Milwaukee, Wis.
Edson Ozro Walker, Chicago, Ill.
Albert Kendall Warren, Los Angeles, Cal.
Curtis D. Weller, Guthrie Center, Iowa
John Blaine Whipple, Newburgh, N. Y.
Ralph Warren Whitaker, Bakersfield, Cal.
James Thomas Wickham, Mt. Folly, Ireland
Leo Cecil Willey, San Francisco, Cal.
Richard Giles Williams, Forrest City, Ark.
Harry Keith Wilson, Bloomington, Ill.
William Henry Wilson, Knoxville, Tenn.
Robert Eubank Witt, Detroit, Mich.
Walter McIlhaney Wolfe, Aberdeen, Md.
Stell Kay Young, Dayton, Ohio

As Associates

William Darcy Craven, Jr., New York City
Clarence Lennon Dewey, Allentown, Pa.
Harry Hauver Hunt, Spokane, Wash.

As Juniors

Louis John Borstelmann, Johnstown, Pa.
Hugh John Casey, Camp A. A. Humphreys, Va.
Valentine Christian, Galeton, Pa.
Thomas Hibben Claussen, Sausalito, Cal.
John Bernard Henry, Calipatria, Cal.
Allan Valentine Hopkins, Sydney, New South Wales, Australia
Harold Stephens Hutton, Perryville, Md.
David Terrill Johnson, Camp A. A. Humphreys, Va.
Mason Hill Kinch, Peoria, Ill.
Hans Kramer, Camp A. A. Humphreys, Va.
Ralph Leonard Morrell, Chicago, Ill.
Marvin Curtis Nichols, Lockhart, Tex.
Luther Emanuel Olson, Cleveland, Ohio
Ragsdale Pace, Fort Worth, Tex.
Frederic Barringer Pfeiffer, Galeton, Pa.
Ralph Adams Smith, Turners Falls, Mass.
Edward Allen Varney, Cambridge, Mass.
Leon Heathman Watson, Ponca City, Okla.
Robert Everett York, New York City

The Secretary announced the transfer of the following candidates on November 25th, 1919:

From Associate Member to Member

Albert Hilands Acher, Washington, D. C.
Alfred Dickey Butler, Spokane, Wash.
Leland Clapper, Two Harbors, Minn.
Alfred John Cleary, San Francisco, Cal.
James Lumsden Ferebee, Milwaukee, Wis.
Herman Henry Fox, Shreveport, La.
Frederick William Green, St. Louis, Mo.
George Elias Halstead, Cincinnati, Ohio
Arthur Carl Lee, Lugoff, S. C.
Charles Winslow Lusk, Oil City, Pa.
Henry Basil Magor, New York City
Charles Allen Merriam, Seattle, Wash.
Robert Edward Moss, Glen Ridge, N. J.
George William Rathjens, St. Paul, Minn.
Gustav Jaeger Requardt, Baltimore, Md.
George Crosby Saunders, Baltimore, Md.
Donald Hubbard Sawyer, Washington, D. C.
Karl DeWitt Schwendener, Los Angeles, Cal.
Arthur Ducat Stivers, Greenville, Tex.
Allen Van-Rensselaer, San Antonio, Tex.
George Linton Watson, Washington, D. C.

From Junior to Associate Member

Ray Lester Allin, Berkeley, Cal.
Curtis Fields Columbia, Chicago, Ill.
Edward Frederic Hammel, New York City
James Buchanan Hays, Boise, Idaho
John Milton Heffelfinger, Jr., Cleveland, Ohio
Tao King, Peking, China
Rolando Arnoldo Martinez, Havana, Cuba
Louis Powers, Newark, Ohio
Fonzie Eugene Robertson, Dallas, Tex.
Walter Wesley Schuyler, Preston, Cuba
Melvin Oliver Sylliaasen, Seattle, Wash.
William Louis Unger, Jamaica, N. Y.

The Secretary announced the following deaths:

William Archer, of Cincinnati, Ohio, elected Member, March 2d, 1881; died November 24th, 1919.

ALBERT JAMES HIMES, of Cleveland, Ohio, elected Associate Member, November 6th, 1895; Member, June 7th, 1899; died November 3d, 1919.

RAPHAEL CHART SMEAD, of Galveston, Tex., elected Member, February 1st, 1905; died November 28th, 1919.

FREDERIC PIKE STEARNS (*Past-President*), of Boston, Mass., elected Member, October 2d, 1878; died December 1st, 1919.

Adjourned.

December 17th, 1919.—Because of the necessity of going to press with this number of *Proceedings* in advance of this meeting, the publication of its minutes must be deferred until January, 1920.

OF THE BOARD OF DIRECTION

(Abstract)

September 9th, 1919.—The Board met at 10.35 P. M., immediately after the adjournment of the Membership Committee; President F. S. Curtis in the chair; Chas. Warren Hunt, Secretary; and present, also, Messrs. Clark, Crocker, Davis, Elwell, Flinn, A. M. Hunt, Langthorn, Lewis, Pegram, Rights, Talbot, Tuttle, and Wagner.

Ballots for membership were canvassed, resulting in the election of 28 Members, 80 Associate Members, 1 Associate, and 16 Juniors, and the transfer of 10 Juniors to the grade of Associate Member.

Thirty-five Associate Members were transferred to the grade of Member.

A report from the Membership Committee was received and acted upon.

Adjourned.

October 14th, 1919.—The Board met at 10.10 A. M.; President Curtis in the chair; Chas. Warren Hunt, Secretary; and present, also, Messrs. Alvord, Clark, Crocker, Davis, Elwell, Fort, Grunsky, Hawgood, A. M. Hunt, Ketchum, Langthorn, Lewis, Marx, Metcalf, O'Connor, Pegram, Rights, Tuttle, Wagner, and Wall.

The minutes of the meeting of the Executive Committee of September 9th, 1919, and the actions taken concerning the appointment of Daniel Bonteeou as a member of the Committee on Development to take the place of C. M. Holland resigned, exemption of dues of members in service, etc., were approved.

The Secretary reported that George H. Tinker, M. Am. Soc. C. E., had been appointed as one of the Society's representatives on the Joint Committee on Culvert Pipe Specifications at the invitation of the American Concrete Pipe Association. The matter of the appointment

of another representative was referred back to the Committee of the Board with power.*

Messrs. H. Eltinge Breed, George W. Tillson, and A. B. Fletcher were appointed a Special Committee on Highway Engineering to keep in touch with the development of the Government's plan for the construction and financing of National highways, and to advise the Society, from time to time, of these plans and activities by the submission of frequent or periodic reports or critical reviews, accompanied by such data as are necessary to indicate the scope and character of the work in progress.

The name of the New York Meetings Committee was changed to "Programme Committee for Second Meeting of Each Month", and the new Committee was appointed, as follows: Messrs. Robert Ridgway, Chairman, Paul G. Brown, Herbert M. Hale, C. Raymond Hulsart, and Chas. Warren Hunt.

The proposed changes in the Constitution of the American Engineering Standards Committee were presented, together with a report on the matter from Messrs. J. Martin Schreiber, Henry J. Burt, and H. N. Latey, the Society's representatives, recommending that an appropriation of $1 500 for 1920 be made for this work, and that the new Constitution be approved.

On motion, duly seconded, the revised Constitution of the American Engineering Standards Committee was approved.

The Secretary reported that at a meeting of the Founder Societies' Finance Committee, on September 16th, 1919, the following resolution was adopted:

"Resolved, that this Committee recommends that each of the Founder Societies provide an annual appropriation for the work of the American Engineering Standards Committee of $500 for each of their representatives on the American Engineering Standards Committee, making a total of $1 500 for each Society that appoints three (3) representatives."

On motion, duly seconded, an appropriation of $1 500 for this purpose was approved to be placed in the Budget for 1920.

The resignation of Onward Bates as Chairman of, and member of, the Committee on Development, and its acceptance by President Curtis, was reported.

The report of the Committee on Development, together with letters of transmittal, signed by Chairman Bates and Secretary Howson, was read in full; also letters from Messrs. Charles Hansel, Onward Bates, Paul G. Brown, and Frederick C. Noble.

A communication from the Secretary of the Committee on Development was also presented, advising that, at the last meeting of the Committee, a Sub-Committee, consisting of Messrs. Richard L. Hum-

*T. L. D. Hadwen, M. Am. Soc. C. E., was subsequently appointed.

phrey, Charles Hansel, and Daniel Bontecou, was appointed to prepare a budget of the estimated cost to the Society of putting into effect the recommendations of the Committee on Development, including those contained in the report of the Joint Conference Committee, and that this Sub-Committee was instructed to submit this Budget over its own signature direct to the Board of Direction for its approval, with the recommendation that this Budget be sent to the members of the Society with the report of the Committee.

The following resolutions were adopted:

"That the Report of the Committee on Development be received, and the Secretary be authorized to add to it the Report of the Sub-Committee on Budget as soon as it is received, and send the report thus completed to the membership as soon after the receipt of the Budget Committee's report as practicable, but not later than November 15th.

"That the Committee on Development be discharged; that the Sub-Committee on Budget be continued until it renders its report and then be discharged; and that the Sub-Committee on Conference with other Development Committees be continued to report to this Board.

"That, in discharging the Committee on Development, the Board desires to thank the Committee for its work.

"That the communications already received, and other communications which may throw light on this matter, be published as soon as practicable in a separate pamphlet, or in *Proceedings*, as the case may be, such publication not to occur until after the publication of the report of the Committee on Development.

"That a Committee of five members of the Board of Direction be appointed by the President to study and review the report of the Committee on Development, and to present a report as soon as practicable for distribution to the members of this Board by letter, so that the Board can consider the whole matter at its next regular meeting."

President Curtis subsequently appointed as such Committee, Messrs. Alvord, Marx, Crocker, Wagner, and O'Connor.

Adjourned at 1 P. M.

The Board reconvened at 2.10 P. M.

On motion, duly seconded, mileage was allowed to the members of the Joint Conference Committee at the same rate as that fixed for the meetings of the Committee on Development.

A resolution was adopted authorizing the President to appoint five members to represent the Society on the Joint Committee to Formulate Specifications for Reinforced Concrete, it being understood that the Joint Committee select its own Chairman.

The report of the Nominating Committee was presented, transmitting the names selected for offices to be filled at the next Annual Meeting, all of whom have accepted such nomination.

The Secretary reported that, on account of the printers' strike in New York City, it will not be possible to issue the October *Proceedings,* and that the membership has been so notified.

On motion, duly seconded, Nelson P. Lewis, Vice-President, was unanimously appointed to serve with George F. Swain, Past-President, as member of the Permanent Franco-American Engineering Committee.

The formation of the Founder Societies Finance Committee on Joint Activities was reported at the June meeting, and Messrs. Nelson P. Lewis and Chas. Warren Hunt were appointed to represent this Society on the Committee. The Secretary reported that this Committee held its first meeting on September 16th, 1919, and the following actions were taken:

(1) Employment Activities: Upon the recommendation of the members of the Board of Directors of the Engineering Societies Employment Bureau, the following resolution was adopted:

"*Whereas,* the Engineering Societies Employment Bureau has been conducted during the past year principally as a war activity, under the auspices of Engineering Council, and

"*Whereas,* the permanent work of this Bureau is a co-ordination of the employment service rendered for many years by several Societies under the direction of their Secretaries,

"*Resolved,* that we recommend to the governing bodies of the four Founder Societies that in making appropriations for employment activities for the coming year, the item be separated from the appropriation for Engineering Council, and that the Employment Bureau be carried on as a separate joint activity of the Founder Societies under the direction of their respective Secretaries, who constitute the present Board of Directors of the Bureau."

The recommendation of the Joint Finance Committee was approved.

(2) Engineering Council: The following resolution was adopted:

"*Resolved,* that having recommended that a separate appropriation be made covering the Employment Bureau's activities for the year 1920, and considering the present financial condition of the Founder Societies, this Committee cannot see its way clear to recommend an appropriation for the year 1920 by each Society of a sum exceeding $3 000 to cover the joint activities conducted under the auspices of Engineering Council, this, however, being a considerable increase over the appropriations made for the activities of the Council for the past two years, in view of the fact that a separate appropriation is being recommended for employment work."

The report was accepted, and an appropriation of $3 000 for this purpose was approved, to be placed in the Budget for 1920.

A report* from Robert A. Cummings, M. Am. Soc. C. E., who, with eight delegates, represented the Society at the ceremonies at the dedication of the New Buildings of the Pittsburgh Experiment Station, was accepted and ordered printed in *Proceedings.*

* See page 935.

The Constitution of the newly formed Connecticut Association of Members of the Society was approved.

Messrs. W. M. Dawley and J. B. Jenkins were appointed additional members of the Special Committee on Stresses in Railroad Track.

The following resolution, passed by the San Diego Association of Members, and transmitted in a letter dated September 19th, 1919, was presented:

"*Resolved:* That it is the sense of this Association that the American Society of Civil Engineers should be urged to pass a resolution requesting the Congress of the United States to create a Department of Public Works as provided for in Senate Bill 2232, which shall have charge of all public construction and work under United States control, and that the American Society of Civil Engineers do all in its power to foster and assist in the creation and operation of said Department."

The Secretary was instructed to inform the Association that the Board has already endorsed the principle.

The President was authorized to appoint a Committee of Arrangements for the Annual Meeting.

President Curtis was appointed as one of the representatives of the Society on the John Fritz Medal Board of Award, on the expiration of the term of Charles D. Marx, Past-President, Am. Soc. C. E., in January, 1920.

Director Harry Hawgood was appointed Chairman of the Local Committee of Arrangements for the 1920 Annual Convention, with power to add to the Committee.

The following resolution presented by C. E. Grunsky, M. Am. Soc. C. E., was referred to the Publication Committee for consideration:

"*Resolved:* That the periodical publication of a professional directory of engineers, restricted to the members of the American Society of Civil Engineers, of the American Society of Mechanical Engineers, of the American Institute of Electrical Engineers, and of the American Institute of Mining Engineers, is desirable and that a plan for such a publication should be worked out by a joint committee from these Societies; and that the Publication Committee of this Society is authorized and directed to co-operate with any representatives of the other Societies above named in working out a plan for the periodical issuance of such a directory."

The resignations of 2 Members (one effective on December 31st, 1919), 2 Associate Members, 1 Associate, and 5 Juniors (three effective on December 31st, 1919), were accepted.

Ballots for membership were canvassed, resulting in the election of 24 Members, 65 Associate Members, 24 Associates, 24 Juniors, and the transfer of 22 Juniors to the grade of Associate Member.

Twenty-three Associate Members were transferred to the grade of Member.

Adjourned.

October 15th, 1919.—The Board reconvened at 1.30 P. M.; President Curtis in the chair; Charles Warren Hunt, Secretary; and present, also, Messrs. Alvord, Clark, Crocker, Elwell, Grunsky, Hawgood, A. M. Hunt, Metcalf, O'Connor, Pegram, Tuttle, Wagner, and Wall.

A report from the Membership Committee was received and acted on.

Applications were considered and other routine business transacted.

Adjourned.

November 25th, 1919.—The Board met at 10.35 P. M., on the adjournment of the Membership Committee; President Curtis in the chair; Charles Warren Hunt, Secretary; and present, also, Messrs. Clark, Elwell, A. M. Hunt, Ketchum, Langthorn, Lewis, Metcalf, Rights, Tuttle, and Wagner.

Ballots for membership were canvassed resulting in the election of 14 Members, 81 Associate Members, 3 Associates, 19 Juniors, and the transfer of 12 Juniors to the grade of Associate Member.

Twenty-one Associate Members were transferred to the grade of Member.

Applications were considered and other routine business transacted.

A report from the Membership Committee was received and acted on.

Adjourned.

REPORT OF THE COMMITTEE ON DEVELOPMENT

PRESENTED TO THE BOARD OF DIRECTION, OCTOBER 14TH, 1919

The Report of the Committee on Development was received at the office of the Society October 9th, 1919, and was considered at the meeting of the Board of Direction held October 14th, 1919, at which time the following resolutions were adopted:

"That the Report of the Committee on Development be received, and the Secretary authorized to add to it the Report of Sub-Committee on Budget as soon as received, and send the Report thus completed to the membership as soon after the receipt of the Budget Committee's Report as practicable, but not later than November 15th.

"That the Committee on Development be discharged; that the Sub-Committee on Budget be continued until it renders its report and then be discharged; and that the Sub-Committee on Conference with other Development Committees be continued to report to this Board.

"That in discharging the Committee on Development the Board desires to thank the Committee for its work.

"That the communications already received, and other communications which may throw light on this matter, be published as soon as practicable in a separate pamphlet, or in *Proceedings,* as the case may be, such publication not to occur until after the publication of the Report of the Committee on Development.

"That a Committee of five members of the Board of Direction be appointed by the President to study and review the Report of the Committee on Development, and to present a report as soon as practicable for distribution to the members of this Board by letter, so that the Board can consider the whole matter at its next regular meeting."

The President subsequently appointed as such Committee, Messrs. Alvord, Marx, Crocker, Wagner, and O'Connor.

The Report of the Sub-Committee on Budget was received at the Society's office November 11th, 1919, and the Report of the Committee on Development, thus completed, was mailed to the entire membership on November 21st, 1919, in accordance with the instructions of the Board above quoted. The report follows:

To the Board of Direction,

American Society of Civil Engineers:

Gentlemen:—The third meeting of the Committee on Development was held in Ann Arbor, Mich., on September 22d to 26th, 1919, inclusive, and was attended by the following members:

Onward Bates, *Chairman*	Charles Hansel
George G. Anderson	John L. Hall
Daniel Bontecou	W. H. Hoyt
J. H. Brillhart	Richard L. Humphrey
Baxter L. Brown	Frederick C. Noble
Paul G. Brown	Arthur Pew
Robert A. Cummings	George R. Putnam
W. L. Darling	Charles J. Tilden
F. T. Darrow	T. L. Wilkinson
H. L. Haehl	Gardner S. Williams

There was present also for a short time Professor M. E. Cooley, Dean of the College of Engineering of the University of Michigan and President of the American Society of Mechanical Engineers.

The first meeting of the Committee on Development was held in Chicago, Ill., on November 14th to 16th, 1918, inclusive; the second meeting was held in Minneapolis, Minn., on June 11th to 16th, 1919, inclusive. At the November meeting, the work of the Committee was sub-divided and four Sub-Committees were appointed. These Sub-Committees prepared reports which were presented at the June meeting and formed the basis for the report presented to the Board of Direction of the Society on June 16th, 1919, and submitted by it to the Society on the following day. At the June meeting of the Committee, a fifth Sub-Committee was appointed to confer with similar committees of the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, and to consider matters of common interest, including the formation of a National organization. The report submitted herewith is based on the work of these five Sub-Committees and is divided into four main sub-divisions which represent, approximately, the scope of the work of the four original Sub-Committees. At the third meeting of the Committee, a Sub-Committee was appointed to prepare a budget to be transmitted directly to the Board of Direction and to be submitted to the membership with this report.

The report transmitted herewith was adopted by the Committee on Development in two sections. That part of Section C, entitled "Report of the Joint Conference Committee," was adopted by the following vote:

Yeas.		Nays.
George G. Anderson	John L. Hall	Onward Bates
J. H. Brillhart	W. H. Hoyt	Paul G. Brown
Baxter L. Brown	Richard L. Humphrey	W. L. Darling
Daniel Bontecou	Arthur Pew	F. C. Noble
Robert A. Cummings	G. R. Putnam	
F. T. Darrow	C. J. Tilden	
H. L. Haehl	T. L. Wilkinson	
Charles Hansel	Gardner S. Williams	

The remainder of the report was adopted by the following vote:

Yeas.		Nays.
George G. Anderson	Charles Hansel	
Onward Bates	W. H. Hoyt	
Daniel Bontecou	Richard L. Humphrey	None.
J. H. Brillhart	F. C. Noble	
Baxter L. Brown	Arthur Pew	
W. L. Darling	T. L. Wilkinson	
H. L. Haehl	Gardner S. Williams	
John L. Hall		

A. TECHNICAL ACTIVITIES

The Committee believes that the standing of a great engineering society depends mainly on the activity and progress of its technical work, and is of the opinion that more active co-operation in movements for public and professional welfare, as hereinafter proposed, should not be allowed to diminish the importance attached to the technical activities of the American Society of Civil Engineers, but rather that these should be stimulated in the interest of science and the profession.

The Committee therefore recommends:

1. Meetings:

That local "sections" hold not less than four stated meetings per year and encourage joint meetings with kindred societies.

That periodic joint meetings of the four National Societies be encouraged.

That the fortnightly meetings of the Parent Society be discontinued.

That the semi-annual meetings of the Parent Society be supplemented by the addition of a spring and a fall meeting, held successively in different sections of the country in co-operation with local sections and that at these meetings as well as at the Annual Meeting and the Annual Convention attention be given to technical and broad economic problems, and that at the Annual Convention at least half the time should be scheduled for the serious consideration of technical matters.

2. Papers:

That the present system of securing papers which depends wholly on voluntary offers and results in a limited variety of subjects be supplemented by papers that will fit into a definite logical programme, directed by the Publication Committee and announced in advance for a whole season; and that papers describing works be brief on the narrative side, with more attention given to stating the technical lessons of successes and failures. Furthermore, that consideration be given to other controlling elements in engineering work as financial, administrative, operating, and labor problems, for if the engineer is to take his proper place and render full service to the public and to his profession, such topics come within the scope of his thought and should appear in the papers of the Society.

That so far as practicable the subjects of the papers should cover current progress, and development of the various important branches of Civil Engineering and simultaneous discussion of important papers by the Local Sections should be encouraged.

That the monthly *Proceedings* should be extended to include editorial work, abstracts and reviews of important engineering articles and subjects of popular interest to the great majority of engineers.

3. Committees:

That in addition to the existing method of conducting the technical activities of the Society there be created advisory standing committees of the Board of Direction to promote and study important engineering subjects and to outline and co-ordinate the work of like committees of the Local Sections; and that three members of the Board should constitute a standing advisory committee on each subject, the chairmen of these advisory committees constituting the Publication Committee; and that Local Sections should urge the younger members to identify themselves with local committee work.

That a standing advisory committee on welfare be created.

That Local Sections suggest names of members possessing necessary qualifications for special committee service, and that tenure of committee membership terminate automatically on account of absence or inactivity. It is suggested that committee reports indicate the attendance of members.

4. Co-Operation with Specialized Engineering Societies and Other Organizations:

That the co-operation of this Society with other specialized engineering and allied technical organizations be fostered and that the Society aid and encourage an active programme of research work, co-operating whenever practicable with other research agencies.

5. Standards in Engineering Practice:

That co-operation with the American Engineering Standards Committee be approved and that it be continued and extended but that the idea of developing this Committee into another association be deprecated.

That the Board of Direction be requested to consider the advisability of compiling a book of recommended principles of practice and standards to follow the development of engineering.

That to carry out the intent of these recommendations effectively the technical editorial staff be under the direction of the Publication Committee.

B. INTERNAL RELATIONS AND LOCAL ASSOCIATIONS

The Committee recommends:

1. Local Sections:

(a) That Local Associations hereafter be called Local Sections.

(b) That every member of the Society be assigned to a Local Section.

(c) That each "geographical district" of the Society be divided into suitable sub-divisions with clearly defined boundaries in each of which there be established a Local Section.

(d) That it be the obligation of all members, either through their Local Sections or individually, to affiliate with members of other engineering and allied technical professions for co-operation in public activities, and in communities where members are few and distant from the meeting place of the Local Sections to which they belong, such affiliation is desirable for co-operation in technical as well as public activities.

(e) That each geographical district of the Society elect its directors by the direct vote of its corporate members, for which purpose there be created a district board consisting of one representative elected by each section in that district, whose duty it shall be to nominate a candidate or candidates for such director, conduct and canvass the returns of the election, and report the result thereof to the Board of Direction.

(f) That the representatives of each district on the Board of Direction of the Society be elected by letter ballot by the corporate members resident in such district.

(g) That any district may elect as director a person not resident therein.

(h) That Local Sections operate under uniform constitutional provisions to the extent only that the same are necessary or desirable to insure uniform relations with the Society and that district boards operate under uniform rules.

(i) That there be allotted to each Local Section a uniform proportion of the dues paid by its members to the Society, said allotment being designed to cover the expense involved in performance of the prescribed duties to the Society, including its proportionate share of the expense of the board of the district to which such section is attached, provided that this be not construed as a limitation of the dues of Local Sections.

(j) That there be held during the Annual Convention a conference of representatives from Local Sections to consider the welfare of the Society and its members and report thereon to the Board of Direction, and that the representatives in attendance be allowed traveling expenses on a mileage basis.

(k) That the Nominating Committee be abolished, and that a candidate for each of the offices of President, two Vice-Presidents and Treasurer be nominated by the annual conference of representatives of the Local Sections in executive session, the relative voting power of the representatives being in proportion to the memberships of the sections represented. The Secretary of the Society shall provide the conference, not less than 30 days in advance of its meeting, with a statement of the membership of the Local Sections as of a date not more than 90 days prior to the meeting of the conference.

(l) That it be the duty of each director to visit each Local Section in his district at least once during each calendar year, without expense to the Society except in cases where, in the opinion of the Board of Direction, the cost to the director would be unreasonable.

2. Membership:

(a) That all applications for admission or transfer be referred for recommendation to the Local Section to which the applicant will be assigned, concurrently with their submission to the membership, and that the name of the Local Section appear on the printed record of the applicant.

(b) That the qualifications for the grade of Honorary Member be that:

They be either distinguished individuals, who from their position are enabled to render assistance in the prosecution of public works, or persons eminent for science and experience in pursuits connected with the profession of a civil engineer, but who are not engaged in the practice of that profession in the United States or its possessions.

(c) That hereafter no person be admitted to the grade of Member who has not occupied the grade of Associate Member for at least two years.

That the quality of "responsible charge" demanded for the grade of Member be of a considerably greater importance than that accepted for the grade of Associate Member, and that the requirements for the

grade of Junior be deducted from the candidate's record in determining his eligibility for the grade of Member.

That the grade of Fellow as now defined terminate with the expiration of membership of those now occupying that grade, and that hereafter a new grade of Fellow be established, the requirements for the members of which shall be:

A person who by scientific or professional attainment has qualified himself in his special pursuit to advise and co-operate with engineers in the advancement of professional knowledge and practice.

That the grade of Affiliate be established into which may be admitted such persons engaged generally in commercial pursuits as possess engineering training and experience qualifying them to be of service to the Engineering Profession.

That the present grade of Associate terminate with the expiration of membership of those now occupying that grade.

That the requirements for the grade of Junior be so changed as to require, in the case of the non-technical graduate, not less than four years of practice in engineering work under the direction of a corporate member of the Society or of an engineer of equivalent qualifications; provided, that time spent as a student of engineering in a college or school of recognized standing be considered the equivalent of an equal amount of practice under competent supervision; also, that in the case of all Juniors the minimum age limit be increased to twenty-one years.

(d) That the provisions of the Constitution relating to discipline and expulsion of members be so revised as to make them effective and that the Board of Direction, on the written request of three corporate members, consider the reasons advanced for discipline or expulsion.

3. Dues of Members of the Society:

That the dues of all members above the grade of Junior be adjusted to provide for the greater activities of the Society and to the extent that the recommendations herein provided are adopted.

That in any modification of the dues of the Society consideration be given to the probability that in the event of the formation of the herein recommended, or any other, comprehensive National organization, the development of its usefulness will ultimately require an income considerably in excess of that thus far provided.

4. Student Societies:

That, recognizing the importance to the young engineer of a broad general training, the formation of specialized student organizations in any of the branches of engineering be disapproved, but in lieu thereof general student engineering societies be established and maintained in

the engineering schools with continued active interest therein and close personal contact therewith by neighboring engineering associations.

5. Young Men of the Profession:

That it be the duty of the Local Sections to provide for the welfare of the younger members of the Profession by:

(a) Reasonable representation on the active committees.
(b) Encouraging their discussion of the general problems of the Society.
(c) Arranging excursions to works of engineering interest, and
(d) Promoting social intercourse between them and the older members.

6. Annual Meeting:

That the Annual Meeting be devoted to the consideration of:

(a) The printed annual reports of officers and standing committees, presented in abstract, unless otherwise ordered by vote of the meeting.
(b) The election and installation of officers.
(c) The presentation and discussion of reports of technical and special committees.
(d) Other matters pertaining to the affairs of the Society and the profession on which action by the Society is desired.
(e) A carefully planned programme of addresses on and discussions of professional or social problems of National importance.

That proper provision be made for sociability, but that this should not be permitted to interfere with the consideration of the more important duties of the Society.

That no excursions be scheduled for the first day of the Annual Meeting.

That the Annual Meeting be so conducted as to enlist the active and sympathetic co-operation of all members of the Society, and that in the formation of the Committee of Arrangements the Board of Direction endeavor to secure the widest possible representation of the membership.

7. Personal Service:

That until the recommendations of the Joint Conference Committee come into effect the Society proceed with such a compilation of the professional records of its members as will assist alike members seeking employment, and employers seeking assistance; and that such data be secured by the Society through carefully prepared questionnaires sent to all members, copies to be furnished to the Personal Service Bureau.

8. Additional Facilities at Headquarters:

That the ground floor of the building be fitted up as a lounging room with club facilities such as files of magazines (other than technical), daily newspapers, theatre ticket board, etc., to be presided over by a capable attendant who shall give cordial and helpful assistance to all comers, in order that the members of the Founder Societies visiting headquarters may realize greater benefits from their membership.

C. RELATIONS WITH OTHER NATIONAL SOCIETIES AND RELATED ORGANIZATIONS

The Committee recommends:

That the identity of the four existing National Societies be preserved.

That the American Society of Civil Engineers continue to pursue the objects for which it was formed as expressed in the Constitution, namely, "The advancement of engineering knowledge and practice and the maintenance of a high professional standard among its members", and that it devote its chief endeavors to the performance of these objects; and that this Society adopt the principle of becoming an active National force in economic, industrial, and civic affairs, and with that purpose in view become an active factor in co-operation with other engineering organizations of the country.

That a comprehensive organization be created as outlined in the Joint Conference Committee Report submitted below.

That this comprehensive organization publish a bulletin without advertising, concerning questions of interest to engineers and allied technical associations, in order that those therein associated may be informed in regard to social and economic matters.

REPORT OF THE JOINT CONFERENCE COMMITTEE

Representing

The American Society of Civil Engineers,
The American Institute of Mining and Metallurgical Engineers,
The American Society of Mechanical Engineers, and
The American Institute of Electrical Engineers.

An informal meeting of the Conferees of the Development Committees of the four Societies was held in New York City on July 2d, 1919, at which the scope of the work was considered, and a Sub-Committee on Procedure, consisting of the Chairmen of the Conferees from each of the four Societies, was appointed to arrange the programme for and the time and place of the first formal meeting. The Con-

ferees subsequently adopted the name, "The Joint Conference Committee."

The Joint Conference Committee convened at the Hotel Montclair, Montclair, N. J., August 13th, 14th, and 15th, and in New York City, September 15th, 16th, and 17th, 1919.

The Committee has divided its report into two parts, that covering the public activities and that covering the society activities of common interest to the four Societies.

1. CO-OPERATION IN PUBLIC ACTIVITIES

It was the unanimous opinion of those present at all conferences that one of the most important matters on which joint action can be taken is the formation of a single comprehensive organization to secure united action of the engineering and allied technical professions in matters of common interest to them.

In presenting its report on a proposed form of organization which shall provide a voice to speak for the ideals of the Profession, a hand to enforce unity of action and render the maximum of national, social, and political service, the Committee presents for consideration the following plan. The Committee emphasizes that the plan can only be valuable and enduring as the motive dominating it is patriotic, broad-visioned, and unselfish, but firmly believes that all efforts toward bringing a united Profession to the service of the Nation, the State, and the City will bring to its members the public honor, esteem, and recognition which their qualifications deserve, now relatively unacknowledged and uncompensated.

In preparing this plan the Committee has recognized that there exists in Engineering Council a tool which is engraving an honorable record on the pages of professional history, but its limitations are well known and its poverty is chronic. If desired, Engineering Council can be moulded into this organization by making it more democratic and founding it on direct representation of all engineers, rather than appointment as at present.

The great object is to provide an effective body, widely and truly representative, modestly yet adequately financed, which will be neither autocratic nor aristocratic, which will at all times stand as the representative and defender of the Profession in matters affecting its honor, welfare, and common interest.

The mandate for a vehicle to provide for co-operation and solidarity among engineers has been unmistakably expressed by the membership of the four Societies, through their several Development Committees. In obedience thereto the Joint Conference Committee has constructed a plan for an organization designed to perform this function by providing an opportunity to use the strength of every existing technical organization in the country, but without taking from them any of their pres-

ent privileges, or in any way interfering with their respective spheres of usefulness.

Every new activity, to be effective, means work and needs money. A movement such as proposed, if undertaken without sufficient funds, would not only prove barren of results, but by failure would bring ridicule on the Profession. In advance of its organization no definite budget can be prepared. The revenues proposed are moderate, and are based on the experience of Engineering Council, which, while called on to occupy an ever widening field, has been continually handicapped by limited resources.

In submitting the proposed fundamentals to govern a single comprehensive organization by which the engineering and allied technical professions may become more active in their service to the public and themselves, the Joint Conference Committee would point out the following as among some of the objects to be attained by such an organization:

(1) To render the maximum of service to the nation through unity of action.

(2) To give the engineers of the country a more potent voice in public affairs.

(3) To secure greater recognition of the services of the engineer, and to provide for his advancement.

(4) To promote *esprit de corps* among the members of the Profession.

(5) To provide the machinery for prompt and united action on matters affecting the Profession, among which are:

Licensing and registration of engineers;
National Service Committee;
National Department of Public Works;
Conservation of National Resources;
Publicity;
Classification and compensation of engineers;
General employment bureau;
Engineering education;
International affiliation of engineers;
Industrial relations.

In the greater vision resulting from the world war it is apparent that no one alone can successfully solve the problems with which he is confronted. He needs the co-operation of his fellows. National problems demand united effort. The Joint Conference Committee believes that the greatest value of the proposed organization is in the united efforts for the service of the nation, from which effort will result the greatest service to the individual.

The general plan offers a definite method of organization for public service. The Committee presents a means whereby the expressed wish of engineers throughout the land may be formulated in organization which shall make for the common weal.

The Committee submits the plan with the confident belief that it will be accepted by the four Societies, that they will make the sacrifices necessary and assume the responsibility of leadership, supporting the movement by virtue of their position in the Engineering Profession. A national movement by local societies is sure to come. The four National Societies can take the initiative and continue their leadership in American engineering by prompt action, or by inaction lose the prestige they now hold.

NATIONAL ENGINEERING ORGANIZATION*

Organization and Purpose:

In order that the engineering and allied technical professions may become a more active national force in economic, industrial, and civic affairs, and in order that united action may be facilitated, it is desirable that there be co-operation through a single comprehensive organization. The purpose of such organization should be to further the public welfare wherever technical knowledge and training are involved, and to consider all matters of common concern to these professions. It should embrace:

Component Parts of Organizations:

1. Local Affiliations, preferably under the auspices of local engineering societies or clubs, as follows:

a. "Local Associations" or "Sections" of the national engineering or technical societies;

b. Local engineering societies; and

c. Other local engineers and members of allied technical professions and associates.

2. A National Council, consisting of representatives of national engineering and technical societies and of representatives of local, State, or regional affiliations or organizations.

The formation of State Councils, composed of representatives of the local affiliations within the State or otherwise representative of the majority of the engineers and members of allied technical professions in the State, is desirable as conducive to co-operation and to further the objects of the National Council, with which such State Councils

* The Joint Conference Committee does not deem it desirable to select definite names for either the organization or its component parts, but believes that this should be left to the action of this organization when formed.

should harmonize; and such State Councils are recommended wherever and whenever the local conditions warrant.

Delimitation of Authority:

Local Affiliations, State Councils (where formed), and the National Council, shall take action on local, State, and National matters, respectively, and they shall be autonomous with respect thereto. It shall, however, be the duty of the National Council to interest itself in the activities of Local Affiliations and State Councils if such activities are of National scope or effect the interest of the engineering and allied technical professions in other parts of the country; provided, that nothing herein stated shall be construed as preventing the discussion by any Local Affiliation or State Council or by the National Council of any matters of interest to engineers and members of allied technical professions.

LOCAL AFFILIATIONS

Purpose:

Local Affiliations are created to consider local matters of public welfare with which the engineering and allied technical professions are concerned, as well as other matters of common interest to these professions, in order that united action may be made possible in local matters.

Constitution:

Each Local Affiliation shall submit its Constitution and By-Laws and all subsequent modifications thereof to the Executive Board of the National Council for approval.

STATE COUNCILS

Purpose:

State Councils may be created to consider State matters of public welfare with which the engineering and allied technical professions are concerned, as well as other matters of common interest to these professions, in order that united action may be made possible in State affairs.

Constitution:

Each State Council shall submit its Constitution and By-Laws and all subsequent modifications thereof to the Executive Board of the National Council for approval.

NATIONAL COUNCIL

Purpose:

The National Council is created to consider National matters of public welfare with which the engineering and allied technical professions are concerned, as well as other matters of common interest to

these professions, in order that united action may be possible in matters of National scope.

Basis of Representation:

Each local, State, or regional affiliation or organization whose membership is not otherwise represented than through the National engineering or technical societies, shall be entitled to one representative to the National Council for a membership of from 100 to 1 000, inclusive, and one additional representative for every additional 1 000 members or major fraction thereof.

Each National engineering or technical society shall be entitled to one representative for a membership of from 200 to 2 000, inclusive, and an additional representative for every additional 2 000 members or major fraction thereof.

Meetings:

The National Council shall hold a stated annual or biennial meeting. Other meetings *may* be called by the Executive Board on its own initiative, and *shall* be called by it on the written request of 25 delegates to the National Council, provided that all notices of special meetings shall be mailed not less than 60 days prior to the date thereof.

Terms of Delegates:

Delegates shall serve for terms of four years; provided that arrangements shall be made by the Executive Board so that an approximately equal number of delegates will be elected each year as provided in the by-laws.

National Headquarters and Secretary:

The National Council shall maintain National Headquarters with a permanent Secretary appointed by and holding office during the pleasure of the Executive Board. He shall not be a member of the Executive Board.

Elected Officers:

The following officers shall be elected by the National Council: A President to hold office for two years, who shall be ineligible for immediate re-election; two Vice-Presidents to hold office for four years, one to be elected every two years; and a Treasurer to hold office for two years.

Executive Board:

There shall be an Executive Board which shall direct the activities of the National Council in accordance with its adopted policies. It shall have such other functions as may be assigned to it by the National Council.

The Executive Board shall consist of the four officers elected by the National Council and one representative for each National society of 2 000 members or less, with one additional representative from each National society for every additional 2 000 members or major fraction thereof, to be selected from the membership of the National Council in each case by the National Society concerned, and of a number of representatives selected from the membership of the National Council by the representatives therein of the local, State, or regional affiliations or organizations, the said number to bear the same ratio to the representation of the National societies as the total membership of the local, State, or regional affiliations or organizations bears to that of the National societies; provided that the numerical basis of representation shall be so changed from time to time that the membership of the Executive Board shall not exceed thirty (30).

The President and Secretary of the National Council shall be the Chairman and Secretary, respectively, of the Executive Board.

Electoral Districts:

The National Council shall divide the country into such districts or regions, as may be desirable to provide for the election of the district members of the Executive Board. In establishing these districts due regard shall be had to geographical conditions and membership.

Admission to National Council:

Any National engineering or technical society or any local, State, or regional affiliation or organization desiring representation on the National Council shall submit a written request to the Secretary of the National Council which shall be accompanied by such data regarding the aims and status of the organization as the by-laws may provide.

The Secretary shall refer this request to the Executive Board, which shall submit it to the delegates, together with its recommendations, for a letter ballot.

The applicant shall be admitted by a majority vote of the National Council, provided that not more than 25% thereof shall vote in the negative.

Unexpired Terms:

Vacancies in the offices of the President, the Vice-Presidents, the Treasurer, and in the Executive Board and delegates, shall be filled as soon as feasible, by the agencies originally selecting the incumbents. Officers and delegates thus chosen shall serve for the unexpired terms.

Finances:

For the purpose of financing the National Council and its Executive Board (not for the use of local affiliations and State Councils), the following assessments shall be made:

Each National Society represented on the National Council shall contribute annually one dollar and fifty cents ($1.50) per member.

Each local, State, or regional affiliation or organization represented on the National Council shall contribute annually one dollar ($1.00) per member.

2. CO-OPERATION IN SOCIETY ACTIVITIES

Careful consideration was given to many points of common interest, and in the time available the Committee feels warranted in taking unanimous action on some of these topics, as follows:

1. Co-Operation in Professional Activities:

The Committee recommends that the growing co-operation in the activities of the Societies be fostered. The unified operation of the libraries, the organization of Engineering Council, American Engineering Standards Committee, Engineering Foundation, and Employment Service, are conspicuous examples of such common action. Joint committees for definite purposes should be established, and standing or other committees directing similar activities in the several societies would profit by conference. In this way common action may be taken or similar policies may be adopted when advantageous, thus avoiding duplication of effort. Comprehensive means should be provided for united action in other larger professional and technical matters.

2. Joint Meetings:

The Committee is of the opinion that periodic joint meetings of the four National Societies in various localities would be beneficial in the development of social intercourse between the members and for debating matters of common interest. Furthermore, such large conferences would bring the engineer forcibly to the attention of the general public.

3. Industrial Relations:

The question of industrial relations is one of the most pressing issues of the present day. It is a vital factor in the economic future of the country. It is a matter with which the engineer is peculiarly fitted to deal. In view of the great importance of the subject, and of the unique relation of the engineer to industry, the Joint Conference Committee recommends that Industrial Relations should be a major subject for the consideration of the engineering and allied technical professions. It is also recommended that support be given to educational movements, such as the Industrial Service of the Y. M. C. A. in colleges, the Americanization movement, and similar activities.

4. Personal Service Bureaus:

It is recommended that the Engineering Societies Employment Bureau be extended by providing for co-operation with the existing

organizations of engineers maintaining employment service, and that on the formation of the contemplated National organization the service be made available to the members of all constituent associations and branch agencies be established in communities where the local engineers desire to co-operate.

5. Student Organizations:

The Committee recommends that it be the duty of local associations and sections of the National Societies to promote and assist general student engineering societies in neighboring universities and technical schools, to provide carefully selected speakers, and to maintain personal contact with such societies. In view of the desirability of more intimate co-operation among engineers, consideration of the affiliation of the student branches of the National Societies into general student engineering associations is recommended.

6. The American Engineer in Foreign Service:

It is the opinion of the Committee that American engineers in foreign countries should be urged to assemble for purposes of better acquaintance and mutual help, and to fraternize with the engineers of the country in which they reside, for the promotion of world-wide co-operation.

7. Standards:

The Committee is unanimously of the opinion that the correlation of standards by the four Societies and others working with them, along the lines contemplated by the American Engineering Standards Committee, should be approved in principle; but in view of the fact that this matter is under consideration by the Boards of Direction of those Societies and the matter is well advanced, this Committee does not feel warranted in making a further recommendation.

8. Arbitration and Expert Testimony:

The Committee is of the opinion that the recommendation of the Committee on Development of the American Society of Civil Engineers in regard to arbitration and expert testimony, namely, that a committee of the American Bar Association be asked to co-operate with a joint committee of the four Societies in order to develop better practice in these matters, should be referred to Engineering Council.

9. Licensing and Registration of Engineers:

The Committee of Engineering Council that has had under consideration the licensing and registration of engineers has nearly completed its draft of a standard form for a uniform law on these matters. Since it is undesirable to duplicate this work, the Joint Conference

Committee recommends that action be deferred pending the receipt of that report.

10. Patent Law:

Since the Patents Committee of Engineering Council, after due consideration, has approved the report of the Patents Committee of the National Research Council, in which definite recommendations are made in regard to the present patent system, it is deemed inexpedient for the Joint Conference Committee to take action on the subject of Patents and the Patent Law.

11. Code of Ethics:

The Joint Conference Committee, after discussion of the question of a code of ethics, reached the conclusion that the matter would require extensive study and careful consideration in order to secure joint action by the representatives of the four Societies, and therefore deemed it unwise to attempt to make a report on this matter at this time.

CONCLUSIONS

The Joint Conference Committee was confronted with a multiplicity of matters inviting consideration, but in the two and a half months of its existence it has been able to consider only the more important ones. The vital matter is the general organization of engineers for public activities, a general plan for which is now submitted for the approval of the Societies.

When the four Societies shall have approved the plan, the Committee holds itself in readiness to work out the details by which it may be put into effect. The Committee has therefore adjourned to meet after this matter has been considered by the four Societies.

George G. Anderson,
Gardner S. Williams,
Richard L. Humphrey,
Chairman.
} Conferees of the Committee on Development, The American Society of Civil Engineers.

Arthur S. Dwight,
Philip N. Moore,
John V. W. Reynders,
Chairman.
} Conferees of the Committee on Development, The American Institute of Mining and Metallurgical Engineers.

Edwin S. Carman,
Dexter S. Kimball,
Louis C. Marburg,
Chairman.
} Conferees of the Committee on Aims and Organization, The American Society of Mechanical Engineers.

Lewis T. Robinson,
Charles F. Scott,
Calvert Townley,
Chairman.
} Conferees of the Committee on Development, The American Institute of Electrical Engineers.

In addition to the above the following members have been in attendance at meetings of the Committee, but were unable to participate in the final drafting of the report: Joseph W. Richards and Allen H. Rogers, The American Institute of Mining and Metallurgical Engineers, and Charles E. Lord, The American Society of Mechanical Engineers.

There was also present by invitation, Comfort A. Adams, Engineering Council.

New York City, September 17th, 1919.

D. RELATION TO PUBLIC AFFAIRS

The Committee submits:

1. Definitions of Engineering:

(a) Engineering is the science and art of directing the great sources of power in Nature to the use and convenience of man.

(b) Engineering is an art and science. It is a science in so far as physical laws are its basis, and an art in so far as in the application of these laws the things designed and constructed develop the spirit of progress, the creation of wealth, and the well-being of all peoples.

Engineering is generally divided into four major divisions, viz., civil, mechanical, electrical, and mining.

The practice of engineering requires knowledge of physical laws, forces, and the materials of Nature.

The professional engineer is one who by reason of special training, education, and experience is qualified to design and direct the construction of engineering work in one or more of the major divisions of engineering.

(c) Engineering is the creative science and art of applying economically the materials and forces of Nature to the use and convenience of man.

(d) Engineering is the science of industrial effort, and the science and art of applying this effort for the welfare of the public.

An engineer is one versed in the science and art of industrial effort made for the purpose of public welfare.

2. Code of Ethics:

(a) A code of ethics for the Engineering Profession is a concise statement of moral principles that are supposed to regulate the professional character and conduct of an engineer regard-

ing himself, his work, his client, his profession, and his fellow men.

(b) The engineer, on entering professional practice, should be suitably prepared for his chosen vocation by education and experience which he will add to throughout his professional career. It is fortunate if he be also endowed by nature with a disposition and qualities of mind especially adapted to the requirements of his profession.

(c) The engineer should find in his work an adequate medium for worthy self-expression. The work he performs should exemplify his ideals of how that kind of work ought to be done.

(d) The engineer and his client should stand in relations of mutual confidence and respect. The nature of the services rendered and the just compensation therefor should be mutually understood and agreed on.

(e) The right relation of the engineer to his profession is succinctly embodied in the golden rule: "All things whatsoever ye would that men should do to you, do ye even so to them."

(f) In relation to his fellow men, the engineer should function as a citizen, neighbor, and friend. Desiring to promote the public welfare, he will assume his civic responsibilities and not neglect his public duties. His professional training should increase his effectiveness in civic relations, and it is proper that his profession should be made to share in any public esteem and honor that attend his own achievements.

The foregoing brief statement of some of the cardinal principles which should guide the engineer is prepared for the purpose of stating clearly the standard of action demanded of all members of the Society and is also intended as a guide for the action of the Board of Direction in the consideration of a particular case where for any reason a member of the Society may be charged with a violation of the ethics of engineering practice.

SPECIFIC INTERPRETATIONS

Therefore, it shall be considered unprofessional and inconsistent with honorable and dignified bearing for any member of the American Society of Civil Engineers:

(1) To advertise in self-laudatory language, or in any other manner derogatory to the dignity of the Profession.

(2) To solicit professional work improperly either directly or by an agent, or to pay, by commission or otherwise, any person who may introduce clients to him.

(3) To act for his clients in professional matters otherwise than as a faithful agent or trustee, or to accept any remuneration other than his stated charges for services rendered his clients.

(4) To attempt to injure falsely or maliciously, directly or indirectly, the professional reputation, prospects, or business of another Engineer.

(5) To attempt to supplant another Engineer after definite steps have been taken toward his employment.

(6) To compete with another Engineer for employment on the basis of professional charges, by reducing his usual charges and in this manner attempting to underbid after being informed of the charges named by another.

(7) To review the work of another Engineer for the same client, except with the knowledge or consent of such engineer, or unless the connection of such engineer with the work has been terminated.

(Adopted by the Society by Letter Ballot, September 2d, 1914.)

3. Engineering Education:

That a carefully selected committee on Engineering Education would be of material service to the engineering schools, but the membership of such a committee should be made up of only those qualified both by training and experience to advise on the subject.

That the aims of engineering education, fundamental requirements, changes in curricula indicated by changing social and industrial conditions, the qualifications of teachers, and the standardization of degrees, are subjects which such a committee should rightly consider, and recommends that a standing committee of seven be created to consider such questions and that Local Sections appoint similar committees to co-operate with educational institutions in their respective territories.

4. Arbitration and Expert Testimony:

That the present practice involving expert testimony and arbitration is not satisfactory, and recommends that a committee of the American Bar Association be asked to co-operate with a joint committee from the four Founder Societies in order to develop a better practice.

5. Publicity:

That the publication of general articles on engineering subjects in standard non-technical magazines be encouraged and recommends that the Society encourage its members to prepare such articles by offering a prize to be awarded annually to the member writing the best article appearing in such a standard magazine, and that in order to give stimulus further recommends that a standing committee be charged with the duty of passing on the relative merits of such articles, reporting their findings to the Board of Direction.

6. Legislation and Development of Natural Resources:

That until the "Single and Comprehensive Organization" is created, as set forth in the Joint Conference Committee Report, Engineering Council or its successor maintain an agency in Washington, D. C., or elsewhere, for the purpose of keeping advised of all proposed Federal legislation and departmental rulings and regulations involving directly or indirectly questions of engineering; and that such agency keep the Society or its Local Sections advised of such matters and that the various Local Sections keep advised on all proposed State legislation affecting engineering matters and actively interest themselves to the end that proper legislation may be enacted. It is also further recommended that such agency and the Local Sections and the National Council keep advised as to the proposed creation of Federal and State commissions, whose activities may affect engineering enterprise; and that the influence of the Locals and the Society at large be directed toward securing the appointment of engineers on such commissions.

7. The Service of the Engineer to the Community, State, and Nation:

That the Engineering Profession owes a duty to the public which it is believed can best be discharged by the active participation of every engineer in the civil work of his locality. To this end it is urged that the engineer join the civic body of his community, and if there be no such organization, that he endeavor to organize the community for civic work in sympathetic co-operation with the governing body. The engineer's duty to the public also requires that he gives his best efforts to matters of State, interstate, and National character, calling on the various engineering bodies for assistance and co-operation when necessary.

8. Patent Law:

That since the Patent Committee of Engineering Council has approved the report of the Patents Committee of the National Research Council, in which definite recommendations are made in regard to the present patent system, and since the National Institute of Inventors has taken active steps to correct and improve patent law and practice, there should be created a standing joint committee of the proposed "Single Comprehensive Organization" to co-operate with other organizations in the continuance of this work.

9. Co-Ordination of Government Activities:

That until the proposed "Single Comprehensive Organization" be created the influence of the Society and each member of it should be directed toward the creation of a Federal department of public works, the secretary of which shall be technically qualified and a member of

the President's Cabinet, and that the law creating such a department should provide for the co-ordination of all Government engineering activities.

10. Industrial Affairs:

That industry is essentially an engineering problem for its fundamentals are safety for the public and employee, economy in the use of invested capital and efficiency in operation, all based on engineering principles. These principles cannot be properly applied without understanding the assisting and conflicting factors encountered, viz. (assuming that the common-purpose of all who work or labor is to accomplish a worthy purpose):

1. Owner, whose essential object is profit.
2. Director, whose essential object is profit for owner.
3. Constructor, whose essential object is profit.
4. Operator, whose essential object is profit for owner.
5. Labor, whose essential object is profit.
6. User, whose essential object is profit (service at minimum cost).
7. Public, whose essential object is welfare.
8. Government, whose essential object is order and welfare.
9. Engineer, whose essential object is safety, economy and efficiency.

That in determining the economics and efficiency of industry it is necessary for the engineer to understand the interrelation of all these various factors just as thoroughly as he must understand the action of materials under stress in order to design a structure.

11. The Joint Conference Report:

The Committee recommends:

(a) That in the proposed National organization there be no membership of individuals, and that such modification in Paragraph C of Section I of the Joint Conference Committee Report be made by the proper agencies as to remove all ambiguity on this subject.

(b) That the title of the proposed organization set forth in the Joint Conference Committee Report shall be the National Council of Engineering and Allied Technical Associations.

E. BUDGET

The Committee recommends that the report of the Sub-Committee on Budget for carrying out the herein proposed programmes, be transmitted to the membership with this report.

ONWARD BATES,
Chairman.
E. T. HOWSON,
Secretary.

REPORT OF SUB-COMMITTEE ON BUDGET OF THE COMMITTEE ON DEVELOPMENT OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

November 11th, 1919.

To the Board of Direction of the
American Society of Civil Engineers,
33 West 39th Street,
New York, N. Y.

Gentlemen:—The undersigned Sub-Committee on Budget presents the following report as provided in the closing paragraph of the report of your Committee on Development*; together with a budget in tabular form.

Committee B has confined its work entirely to an analysis of the probable additional expense to the Society in carrying out the recommendations of Committee A. It has conferred with the Secretary, has considered the data obtained from the records of the Society, and submits the following reasons for its conclusions as to the various items contained in its budget.

A. SOCIETY ACTIVITIES

1. Meetings:

There are about 18 bi-monthly meetings each year and, on the basis of the cost of the last 33 meetings held, these meetings cost about $3 747 per annum. Committee A recommended "that the fortnightly meetings of the Parent Society be discontinued" and "that the semi-annual meetings of the Parent Society be supplemented by the addition of a spring and a fall meeting". Committee B has estimated the cost of the two meetings as $1 500. The charge for the use of a meeting room for bi-monthly meetings is included in their cost, and as this charge would have to be met by the Founder Societies if these meetings were discontinued, 25% of this cost, i.e., $165, has been considered as a continuing expense.

Committee B is of the opinion that the recommendations of Committee A in regard to the procedure at the Annual Meeting and the Annual Convention would involve no additional expense.

2. Committees:

It is the present practice of the Society to allow mileage for each member in attendance at committee meetings. Under the plan recommended by Committee A, the work of technical and other committees

* Hereinafter the Committee on Development will be designated as "Committee A" and the Sub-Committee on Budget as "Committee B".

of the Society will be carried on by committees of Local Sections under the general direction of advisory committees composed of members of the Board of Direction. Committee B feels that meetings of advisory committees to consider reports made by committees of Local Sections can be held either just preceding or following meetings of the Board of Direction, and they would, therefore, require no additional mileage. While the expense of postage, writing letters, and manifolding reports that are circulated between committees of Local Sections and advisory committees of the Board of Direction, would probably be more than covered by the saving in the mileage at present allowed for committee meetings, there might be unforeseen contingent expenses, and for these Committee B has provided $1 100.

3. Local Sections:

The allotment of funds to Local Sections, provided for in the report of Committee A, is to apply to "the expense involved in the performance of the prescribed duties to the Society, including its proportionate share of the expense of the board of the district to which the section is attached, provided that this be not construed as a limitation of the dues of Local Sections". Committee B believes that an average per capita allotment of $1.00 would be reasonable, which is only to be applied to the administrative expenses of the Local Sections. Committee B feels further that the Board of Direction would use its discretion in the allotment of these funds and, therefore, the aggregate amount $9 000 is to be considered and not its proportionate allotment to any Local Section.

Committee A recommended the abolishment of the Nominating Committee and in lieu thereof provided for an annual conference of representatives of Local Sections to consider the welfare of the Society and to nominate a candidate for each of the offices of President, two Vice-Presidents, and Treasurer. For the last three meetings of the Nominating Committee the expense for mileage per member was about $88, which figure has been used in computing the mileage of members of both the Nominating Committee and the annual conference of representatives of Local Sections. Committee B reviewed the present geographical distribution of the membership of the Society and feels that the provision in the report of Committee A "that every member of the Society be assigned to a Local Section", would not require 40 Sections, but has used this figure as a basis for its analysis. While the meetings of the Nominating Committee are rarely fully attended, and this might be equally true of the annual conference of representatives of Local Sections, Committee B has used the maximum attendance as the basis of its estimate. The expense of this annual conference, in addition to mileage, has been estimated by Committee B as $125.

The report of Committee A provides "that it be the duty of each director to visit each Local Section in his district at least once during each calendar year, without expense to the Society except in cases where, in the opinion of the Board of Direction, the cost to the director would be unreasonable". Committee B feels that $500 is ample for this purpose.

4. Publications:

The report of Committee A provides "that the monthly *Proceedings* should be extended to include editorial work, abstracts and reviews of important engineering articles and subjects of popular interest to the great majority of engineers". Committee B considers that the above recommendation contemplated an amplification of the list of engineering articles now published in the monthly *Proceedings* by the addition of more detailed information as to the contents of each paper listed, which would greatly enhance the usefulness of this list, and also some extension of the non-technical items of interest now published in *Proceedings,* and has concluded that this work would involve an additional expense of $2 000 for the compilation and $1 500 for the printing, and that there would be a further expense of $3 000 for editorial service. Committee B considers that the reviews and editorial work would not include expressions of opinion. The total increased expense of $6 500 has been divided into separate items so as to avoid the assumption that there is contemplated the employment of a $6 500 man for editorial work.

5. Book of Principles of Practice and Standards:

The report of Committee A states "that the Board of Direction be requested to consider the advisability of compiling a book of principles of practice and standards which will be revised periodically to follow the development of engineering". Since Committee A did not recommend that this be done, no estimate of the cost is included in this report.

6. Dues:

Committee A recommended "that the dues of all members above the grade of Junior be adjusted to provide for the greater activities of the Society and to the extent that the recommendations herein provided are adopted". Committee B in considering the matter recognizes that the creation of Local Sections to include all members and the abolition of fortnightly meetings, as recommended by Committee A, appear in a degree to eliminate the reasons for classifying members as "Resident" and "Non-Resident", and is of the opinion that any adjustment of dues "to provide for the greater activities of the Society" must necessarily

tend to raise the dues of non-resident to a parity with the dues of resident members.

B. JOINT ACTIVITIES WITH OTHER SOCIETIES

1. Social:

The report of Committee A provides "that the ground floor of the building be fitted out as a lounging room with club facilities such as files of magazines (other than technical), daily newspapers, theatre ticket board, etc., to be presided over by a capable attendant who shall give cordial and helpful assistance to all comers, in order that the members of the Founder Societies visiting headquarters may receive the benefits from their membership"; Committee B has examined the first floor lobby, made an estimate of the cost of additional furniture and fittings, and has estimated the cost of attendance and maintenance; depreciating the cost of furnishings and fixtures on a basis of 10% a year and adding this to the cost of operation and maintenance, there would be an annual charge of about $3 000 to each of the four Societies; while these facilities must be provided by the United Engineering Society, it requires the favorable consideration of the representatives of these four Societies to carry out the recommendation.

2. National Council:

The recommendation of the Joint Conference Committee which was approved by Committee A, provides for "the formation of a single comprehensive organization to secure united action of the engineering and allied technical professions in matters of common interest to them". This organization would necessitate the payment by the Society of $13 500, for 9 000 members on the basis of the per capital amount recommended by the Joint Conference Committee. The work of this organization would supersede the work that Engineering Council is now doing and thereby relieve the Society of its annual payment of $4 000 to Engineering Council; Committee A further proposes to transfer the Engineering Societies Employment Bureau to the National Council of Engineering and Allied Technical Associations, which would further relieve the Society of an annual payment of about $4 000. These two savings would make the net additional expense $5 500.

Committee A recommended that the "comprehensive organization publish a bulletin without advertising". It is obvious that an estimate of the cost of a bulletin would be dependent upon its size, character, circulation, and frequency of issue. Committee B calls attention to the fact that the Joint Conference Committee report contains no reference to a bulletin, and it has been advised by competent authority that the cost of such a bulletin might be entirely met by proper advertising.

Committee B has not attempted to prepare a budget for the National Council of Engineering and Allied Technical Associations, as it feels that the amount that will be provided will be adequate to care for its existence during the earlier period, and that if the work of the National Council is of a character to warrant, there will be no difficulty in securing any additional funds that may be needed.

The budget of Engineering Council for 1919 is given by its Secretary as $50 000; if to this is added the amount for mileage of members in attendance at meetings of the National Council and of its Executive Board, as provided in the report of Committee A, this budget would be increased to $75 000. The recommendations of the Joint Conference Committee would yield an income greatly in excess of the present income of Engineering Council.

On the conservative basis of 40 000 members of the four Founder Societies at $1.50 per member, making no allowance for the membership of other National Societies, and assuming that there will be at least 20 000 members from local affiliations at $1.00 each, there will be available $80 000, and Committee B feels that this initial annual income will be sufficient for the earlier expenses of the organization provided in the Joint Conference Committee report.

In accepting the conclusions of the Joint Conference Committee, which provided that members of the four Founder Societies should be assessed $1.50 per member per annum to support the proposed new organization, Committee A stated: "that in any modification of the dues of the Society, consideration should be given to the probability that in the event of the formation of the herein recommended, or any other, comprehensive National organization, the development of its usefulness will ultimately require an income considerably in excess of that thus provided".

Committee B calls attention to the fact that the above mentioned $1.50 is to be paid by the Society out of the dues of each member, and that, if he is a member of a Local Affiliation that is represented on the National Council, he must pay $1.00 toward the expenses of the National Council.

3. American Engineering Standards Committee:

Committee A recommended that the work of the American Engineering Standards Committee be continued and extended. The Board of Direction has already made appropriations for its work amounting at present to $1 500 per annum. The extension recommended is the co-operation with additional Societies whose participation would increase the funds available, consequently, Committee B has made no provision for additional expense on account of this recommendation.

C. RECAPITULATION

The aggregate increase in expense to the Society of carrying out all of the recommendations of Committee A would be about $25 000.

The element of contingent expense, plus or minus, has not been dealt with in the summation of estimated additional cost as it is obvious that the total will be affected by the extent to which the present activities are increased.

The records of the Society show that for the pre-war period, 1897-1916, inclusive, an average of nearly $17 000 per annum was realized and used to reduce the indebtedness on the Society property. The deficit last year was caused by extraordinary conditions due to the war. The increased cost of the present over the former headquarters and other expenses warrant the assumption that the yearly surplus that can be realized, if the recommendation of Committee A as to the continuance of the present technical activities of the Society is carried out, will be considerably less than that realized during the above mentioned pre-war period. The Society has always been more or less handicapped by lack of funds in carrying on its technical activities, and this has been particularly true during the past two years. While there may be a surplus sufficient to cover the increased expense of some of the activities, it would not be sufficient for all those recommended, notwithstanding the increase in the membership of the Society. This is especially true when the greatly reduced purchasing power of the dollar is considered.

Committee B is of the opinion that while it is not constituted as a Committee on Ways and Means, it may be entirely proper for it to suggest that, in order to provide for all of the activities recommended by Committee A, it will be necessary to so readjust the dues as to increase the annual income of the Society.

Respectfully submitted,

Daniel Bontecou,
Charles Hansel,
Richard L. Humphrey, *Chairman*,
Sub-Committee on Budget.

B. Joint Activities with Other Societies.

1. Social.

		Additional Facilities in Lower Floor Lobby of the United Engineering Societies Building....	$3 000.00		$3 000.00
		2. National Council.			
Abolish Engineering Council as now constituted	4 000.00	National Council (9 000 Members @ $1.50 each)	13 500.00		9 500.00
Transfer the Engineering Societies Employment Bureau....	4 000.00			4 000.00	
			$16 500.00		$12 500.00
			8 000.00		4 000.00
		Total additional expense	$8 500.00		$8 500.00

C. Recapitulation.

	Decrease in Expense	Increase in Expense
A. Society Activities.		
1. Meetings	$2 082.00	
2. Committees		$1 100.00
3. Local Sections		11 194.00
4. Publications		6 500.00
		$18 794.00
		2 082.00
Total additional expense		$16 712.00
B. Joint Activities with Other Societies.		
1. Social		$3 000.00
2. National Council		5 500.00
Total additional expense		$8 500.00
Total additional expense A.....		16 712.00
Total additional expense B.....		8 500.00
Total additional expense of all activities		$25 212.00

November 11th, 1919.

BUDGET ACCOMPANYING REPORT OF SUB-COMMITTEE ON BUDGET OF THE COMMITTEE ON DEVELOPMENT TO THE BOARD OF DIRECTION OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

This Statement Deals with the Finances of the Society Only in so Far as They Would be Affected in Carrying Out the Recommendations of the Committee on Development.

Cr.		Dr.	Decrease in Expense	Increase in Expense
	A. SOCIETY ACTIVITIES.			
	1. Meetings.			
Discontinue Society Bi-monthly Meetings $3 747.00	Inaugurate Spring and Fall Meetings	$1 500.00	$2 247.00	
	25% cost bi-monthly meeting room	165.00		$ 165.00
	2. Committees.			
	Expenses Advisory and other Committees	1 100.00	.....	1 100.00
	3. Local Sections.			
	Allotment of Funds to Local Sections (9 000 Members averaging $1 each)	9 000.00	.....	9 000.00
Abolish Nominating Committee:	Annual Conference of Representatives of Local Sections:			
Mileage 19 Members 1 672.00	Mileage on basis 40 Sections.....	3 520.00	.....	1 848.00
Notices: Printing, Postage, Mailing, etc. 279.00	Incidental Expenses of Conference	125.00	154.00	
	Visits of Directors to Local Sections	500.00	.....	500.00
	4. Publications.			
	Extension of Monthly *Proceedings* to Include Editorial Work, Abstracts and Reviews, etc.....	6 500.00	.....	6 500.00
		$22 410.00		$19 613.00
		5 698.00		2 401.00
	Total additional expense	$16 712.00		$16 712.00

LETTERS RELATING TO THE REPORT OF THE COMMITTEE ON DEVELOPMENT

In accordance with the instructions of the Board of Direction, previously quoted, the following communications regarding the work of the Committee on Development are published:

MR. ONWARD BATES,
Chairman, Committee on Development,
Ann Arbor, Mich.

DEAR SIR.—Regarding the nomination and election of officers in the Am. Soc. C. E., I notice in the June, 1919, report of your committee that there is one good change proposed, namely, for the election by ballot by the corporate members of a district of the representatives of such district on the Board and the Nominating Committee.

This is a step in the right direction but I think it does not go far enough. The present system in our Society for the nomination and election of officers seems to me weak and unsatisfactory from lack of participation by the membership in the proposal of names and in the discussion of candidates. The nominations are left almost entirely to the Committee, its proceedings are secret and confidential, very few of the outside members offer recommendations in comparison with our total membership, and the Committee members themselves have too limited opportunities for a full investigation of available material for candidates either before or during their formal meetings.

Then there is only one name selected by the Committee for each office or position to be filled. So that unless there should be added "nominations by declaration" the ballot offers no choice or alternative to the voting member, unless he resorts to scratching the ticket which would probably bring no result, and so the voting at the annual election is reduced to the merest formality. Is it any wonder that many of the members do not think it worth while to cast their ballot?

Contrast this with the system of elections in our country for President, for Congressmen, and for State, county, and municipal officers. In these there are campaigns extending through months in which nearly every citizen participates, either from partisan reasons or with the higher motive of the welfare of himself and his community or State, and takes a personal interest in it as he should do. This results in careful scrutiny of men for candidates, and usually two or more candidates are placed on the ballot for election and there are further discussed.

Why not profit by such an example of popular suffrage? I would suggest that our Society do away with the Nominating Committee entirely and nominate candidates by direct votes of the corporate membership. This might be called the primary ballot. Then there should be placed on the ballot for the annual election at least two names for each of the several positions to be filled, these names being those receiving the highest number of votes in the primary ballot.

Such a method I believe would secure better men, generally speaking, at least men more truly representative of the Society membership, for the administration of our National Society, and what is of even greater importance it would, I feel equally sure, awaken among the

membership a much greater interest in the Society affairs, and would put new life into the Society which would insure its future progress and permanence.

Very respectfully,

J. H. Darling, M. Am. Soc. C. E.

Duluth, Minn., September 21st, 1919.

To the Members
of the Committee on Development:

Gentlemen.—Whatever be the fruit or merit of the report we have just completed, we have given to the making of it our thoughtful and fair-minded effort. The least that can be said for it is, that a large purpose has been launched.

The launching of a ship means, generally, that the shell of a commerce unit lies ready for its co-ordinated machinery and compass. We have understanding of all the multitude of things necessary to the completion and operation of the ship; such knowledge having come through the work of many minds, through centuries of time. Shall we then have reasonable hope that this shell we have launched upon the uncharted sea of minds, without a compass and without plainly understood and co-ordinate structure, shall reach the port of general and common understanding?

We of the Committee have given of our time and of our best creative effort; our Society has given of its treasury; and many members are awaiting the report; but many there be who will not give sufficient study to the report to enable them to arrive at a thoughtful decision on the matter; and, probably, these last mentioned will be the majority. I presume the report will be sent out without comment by any officer of the Society.

I am firmly of the opinion that, unless the Society is aroused to the full purpose of the report and each member is made to realize the great need of quickening the Society in its technical work, as well as in the broad spirit of knowledge and lively participation in the affairs of State and Nation, the labor of our Committee and the cost to the Society will have been in vain. On the other hand, I am as firmly convinced that proper propaganda will meet with quick response and result in providing all necessary funds to carry on the work of advancing the profession, both technically and materially.

When we think that the daily change received from a five-cent piece in the purchase of a newspaper by each member of our Society, if turned into the fund required to carry out the work outlined in our report, would furnish money greatly beyond the needs of the work, it seems contemptible to our profession and our standing in the world's affairs, to for one moment consider that members of our Society—or of any other technical society—would pause an instant to decide whether these few cents should go into the world's work fund or be pocketed for personal use.

Why not, then, prepare a statement of the Committee and request that it be sent out with our report? If such procedure be overruled for any cause, let us then send it ourselves to at least the officers of all affiliated or local organizations of our Society; and request the Conference Committee to take like action, in respect to that part

of our report which deals with the proposed "National Council of Engineering and Allied Associations". Our appeal could also be made through the technical press.

There are forceful and eloquent speakers in our Committee—among whom I regret that I cannot number myself; and this regret is based upon the desire to aid in fertilizing the seed bed of deterioration, i.e., inertia. These men of our Committee, and others of our members who are gifted with the grace of speech—so potent in any campaign of uplift, are generally likewise gifted with willingness to work for the good of others. Our report gives them an opportunity and a responsibility which I am certain they will grasp; but all work, to be effective, must be organized. Consequently, I think we should take immediate steps to organize a speaking campaign and, no doubt, many helpful lessons will be gained from the ardent campaign now being made in and about Chicago.

As I think back upon the days of our three meetings and remember the men gathered from their personal work to try and serve their fellows, I am glad I was given an opportunity to sit with you. I am also obsessed with the feeling that, in our final approval of our report, each of us assumed the obligation of making plain to others its intent and purpose; and, irrespective of our individual opinion as to particular items, words or phrases, we shall personally urge its adoption with such Additions and Betterments as may make for clarity without defeating the purpose of (*a*) enlarging and bettering our Society and (*b*) creating "a single and comprehensive organization to further the public welfare wherever technical knowledge and training are involved and to consider all matters of common concern to" engineering and allied technical professions.

Trusting that I have not greatly wearied you in this writing, and with great personal esteem for each member of the Committee, I am, gentlemen of the Committee,

Yours faithfully,

SEPTEMBER 26TH, 1919. CHARLES HANSEL.

TO THE BOARD OF DIRECTION,
AMERICAN SOCIETY OF CIVIL ENGINEERS:

At the Ann Arbor meeting of the Committee on Development, the undersigned voted with the minority against the adoption of the joint conference report. He objected there to the incorporation of the report in the Committee's report, believing that, in view of its origin, nature and subject-matter, the proper course would be to transmit it independently to the Board with so much parallel action as might be called for by the main, or rather sole, issue before the Committee—to outline a policy by which, quoting the original resolutions, "the Society may take its proper place in the large sphere of influence and usefulness now opening to the Profession." By the action taken, the Committee indicates its view that the Society's proper place in the larger sphere is not an important one.

The provisions of the report relating to representation on the proposed National Council entirely fail to accord proper recognition to the Society. No figures have been brought out to show how the Society would be represented numerically, but the following figures

are based on a list, published this year by *Engineering News-Record*, of engineering and related organizations. There are at least 247 such organizations in the United States, with a total membership of 263 000. Of these, many are commercial or trade organizations, some are architectural, highway, or gas associations, and a few are scientific societies. Deducting these for the moment and taking only those appearing to be composed largely of engineers in one or another well-recognized branch, we have the following numbers and representation:

No.	Kind.	Members.	Council.	Executive Board.
1	Am. Soc. C. E.	9 030	5	2
3	Other Founder Societies	28 002	14	7
27	Other National Societies	31 913	30	8
12	Regional Societies	8 073	13	2
24	State Societies	10 226	25	2
50	Local Societies	20 567	40	5
117		107 811	127	26

Thus, the Society would be represented by 4% in the Council and 8% in its Executive Board. In the above, local organizations in the same center are treated as affiliated, but local sections of National Societies are not included. If these be included, as in the Committee's plan they would, the Society's representation would be smaller, and still smaller if technical organizations generally be admitted or if local societies choose to be represented directly. Any five local affiliations, each of 100 members, would be as fully represented in the proposed Council as the Society. It would make little difference, therefore, in the general scheme if the Society, as a National body, were non-existent.

The American Society of Civil Engineers has been the foremost National engineering society for many years, and it should be the effort of every member to hold that position for it. Its continuing growth without loss of quality and its continuing prosperity show it to be in a healthy condition, injurious statements to the contrary notwithstanding. In name and in fact it represents the nearest approach that there is to a comprehensive organization of the Engineering Profession in America. Within its peculiar province fall more of the most important matters listed in the Joint Conference Report as affecting the profession than in that of any other technical society. It has less to gain and more to lose than any other in any merger such as that proposed.

The writer agrees with his fellow-members of the Committee as to the desirability of an engineers' organization for united action on non-technical matters of common interest, and to that end, as well as to stimulate greater technical activities, favors the aid and increase of local sections to the logical limit, with reservations to guard the interests of members unable to participate actively in their work and to preserve the unity of the Society as a whole. In his opinion, no movement which fails to take practical account of the preponderant influences of the leading National engineering societies is likely to succeed. Moreover, no plan to magnify the importance of local sections at the expense of the National societies to which they belong

can benefit either. In this connection, some facts as to the Society's local sections may be cited.

There are 22 such sections, with a total membership of about 1 500, representing one-sixth of the total membership or, on the average, about one-fourth of the membership in districts where such sections exist. All but 3 were organized in the period 1912-17 and since then there have been no new ones. During the past three years membership as a whole in the local sections has remained about stationary, while in the whole Society the non-resident membership has increased about 15 per cent. The number and character of meetings vary greatly. Four hold only an annual meeting, and others meet monthly or oftener. More than half hold few, if any, technical meetings. The average attendance at meetings is about one-fourth of the section membership in most cases. Annual dues are generally from $2 to $3, are $5 in the San Francisco section, and in some sections are voluntary. Five at least publish Year-books and a few print *Proceedings* and technical papers. Possibly four sections are inactive, since they report no activities and do not respond to inquiries. Seven at least are federated with other technical bodies in their respective centers to form local affiliations for social or civic purposes. In general, the local sections of other National societies in such centers exceed ours in membership.

Respectfully submitted,

FREDERICK C. NOBLE,
Member, Development Committee, Am. Soc. C. E.

NEW YORK, OCTOBER 9TH, 1919.

DR. CHARLES WARREN HUNT, *Secretary,*
American Society of Civil Engineers,
29 West 39th Street, New York City.

DEAR SIR.—As a member of the Development Committee I should like to advise the members of the Society that when fifteen affirmative votes were secured for the adoption of the "Remainder of the Report" no opportunity was given to other members of the Committee not then present to vote.

I feel sure that a number of members of the Committee who voted for the report do not approve of or believe that this report outlines the best method for the re-organization of the Society and merely approved the report to get it before the members of the Society for their information and discussion.

It was the opinion of the Committee as expressed by a majority vote that the funds provided for the proposed comprehensive organization were not sufficient to carry out its purposes. The undersigned was obliged to leave the conference before the report was finally adopted and this expression of opinion was reconsidered by the small number of the Committee then present and is omitted from the report.

The engineers of the country can well afford to contribute much more than $1.00 per year for the general welfare of the Profession and unless they are willing to do so the comprehensive organization should not be formed. It costs money to maintain an organization and get results and unless properly financed the comprehensive organization will be a sure failure.

I believe that the comprehensive organization as outlined by the Joint Conference Committee report would result in the decline if not in the destruction of the Founder Societies.

The first paragraph of Section *c* of Article 2 of the Report bearing on Internal Relations will result in the refusal of many able and well-qualified engineers to join the Society.

Respectfully submitted,

NEW YORK, NOVEMBER 15TH, 1919. PAUL G. BROWN.

ITEMS OF INTEREST

The Committee on Publications will be glad to receive communications of general interest to the Society, and will consider them for publication in *Proceedings* in "Items of Interest". This is intended to cover letters or suggestions from our membership covering matters which are not of a technical character. Such communications, however, must not be controversial or commercial.

International Railway Congress Association

The "International Railway Congress Association" has just been reconstituted under the title of "International Railway Association."

The following are a few notes on the origin, work, and aim of this institution, supplied by the Secretary General, L. Weissenbruch, of Brussels, Belgium.

Like the Institute of International Law, it was one of the earliest of those international scientific societies which are now so numerous.

The foundations of the Association were laid at the congress convoked at Brussels in 1885 by the Belgian Government for the purpose of celebrating the Fiftieth Anniversary of its railways.

At this first assembly, as well as during the sessions which followed, the delegates occupied themselves exclusively with the study and discussion of a number of technical or administrative questions having as their object the progress of railway science.

Nevertheless, the initiator of this reunion, the first president of the Permanent Commission of the Association, Mr. Fassiaux, had had in view, at the beginning, a somewhat different idea, which was to bring into existence a Railway Union after the fashion of the postal and telegraphic unions. He became gradually convinced that such an end was unattainable, however, and thereafter devoted himself entirely to the other idea of creating a permanent center for the meeting of periodical scientific congresses.

The Permanent Commission appointed by the first congress assembled at Brussels on February 20th, 1886.

One of its first concerns was to prepare a draft list of statutes, the final text of which was adopted at the Milan session in 1887. The modifications which have since been made in them are of minor importance.

The Association is composed of administrations of State railways, and concessionary or exploiting administrations of railways of public interest, which have applied for membership, and have been admitted by the Permanent Commission. For a request for admission to be assured of a welcome it is necessary, in particular, that the railway shall be open to the public service, and shall have a minimum extent

of 62 miles for mechanical or electric traction, or 31 miles in the case of rack railways or analogous lines.

Each of the railway administrations constituting the active membership of the Association can appoint a number of delegates to a session, in proportion to the extent of its system, but limited to a maximum of eight.

The Governments of the countries to which the Association extends are invited by the Belgian Government, through the usual diplomatic channels, to give it their support. They themselves fix the amount of their annual contribution to the Association, and thus become patrons. When the sessions are about to be held, each Government nominates, through diplomatic channels, a number of delegates in proportion to its annual subsidy.

The Association is represented by a Permanent Commission which it elects, and which has its seat at Brussels. This commission is at the present time composed of ex-presidents of the sessions, who are members *ex-officio,* and forty-five elected members; its president is Mr. G. Condelier, Presiding Director of the Executive Committee of the Belgian State Railway, and its General Secretary, Mr. L. Weissenbruch, Chief Engineer and Managing Director of the same railway.

At its first meeting after a congress, the Permanent Commission delegates five of its members to form an Executive Committee with the President of the Commission. The Committee is responsible for the management of current affairs and financial business, the supervision and management of all investigations, studies, and publications, the editing of the *Bulletin,* and the care of the library and archives.

The principal changes in the provisions of the statutes, which experience has proved to be advisable, are regular intervals of five years instead of two years between the sessions, the limitation of questions to four for each of the five sections (way and works, locomotives and rolling stock, working, general, and light railways), and the nomination for each question of several reporters, one for each group of countries.

The following table gives the list of sessions of the Association with, in each case, the number of Governments supporting it as patrons, and of railway administrations constituting the active membership, the extent of the railways represented, and the number of the delegates.

Sessions.		Governments.	Number of Railways	Total Mileage.	Number of Delegates:	
					Appointed.	Present.
1 Brussels	1885	19	131	31 070	361	289
2 Milan	1887	26	165	33 466	413	332
3 Paris	1889	34	208	104 603	675	591
4 St. Petersburg	1892	47	262	128 887	788	374
5 London	1895	43	326	171 767	1 048	793
6 Paris	1900	48	338	208 999	1 265	911
7 Washington	1905	44	409	315 665	1 206	582
8 Berne	1910	48	420	359 858	1 370	799

This table shows how rapid has been the development of the Association.

The questions dealt with during the different sessions touch on all the branches of the work of railways: their construction, working, administration, and legislation. The reports which have served as bases for the discussions and resolutions are of particularly high value, since they are the result of searching inquiries made of all the railway administrations. In this way, extremely valuable material has been collected, and arranged in order with great skill and talent by experienced specialists.

These reports form a series of monographs, which, in their entirety, constitute an encyclopedia such as every railway director or engineer has a direct interest in having always at hand.

The discussions have for the most part been conducted on a very high level, and the exchanges of opinion which have followed have been such as to bring to form valuable supplements to the inquiries made by the reporters.

The Association published up to 1914 a monthly *Bulletin* containing, besides original articles on all questions relating particularly to the technique, working and organizations of railways, reproductions of the most interesting articles appearing in the railway reviews of the whole world, and detailed reviews of works dealing with railway affairs.

The *Bulletin* likewise contains reports of all the questions dealt with during the sessions of the Association, as well as full accounts of the discussions.

Edited in the French language since its inception in 1887, the *Bulletin* has also issued an English edition since 1896.

Separate extracts from the reports published in the *Bulletin* are sent to the delegates in order to assist them in their preparations for the sectional discussions.

Finally, a complete review of the session, including the reports and discussions on the various questions, is sent to the delegates after each session.

At the closing sitting of the eighth session (Berne, 1910), when the Twenty-fifth Anniversary of the foundation of the Association was celebrated, it was decided at the final general meeting that the ninth session should take place at Berlin in 1915.

The preparations for this session were far advanced in 1914, when the declaration of war by Germany on Belgium was made. The invasion of the country, and the measures taken by the occupying powers, resulted in the paralysis of activity on the part of the Association for nearly five years.

After the return of the Belgian Government, the Association was placed under sequestration, in pursuance of the Belgian law of November 10th, 1918, owing to the fact that a portion of its assets belonged to the subjects of enemy nations.

The sequestrator having ordered the dissolution and liquidation of the Society, the railway administrations, members of the Association, belonging to thirty-five countries in and outside Europe, decided to transfer their property to an Association established upon exactly the same bases as before, and entitled the "International Railway Association."

These countries are: Argentina, Belgium and Colony, Bolivia, Brazil, Chili, China, Costa Rica, Cuba, Denmark, Dominican Republic, Ecuador, Egypt, France, Algeria, Tunis, and Colonies, Great Britain and Ireland, India, Protectorates and Colonies, Greece, Haiti, Italy, Japan, Luxemburg, Mexico, Netherlands and Colonies, Nicaragua, Norway, Paraguay, Peru, Portugal and Colonies, Rumania, San Salvador, Serbia, Siam, Spain, Sweden, Switzerland, United States of America, Uruguay.

The Executive Committee, which had received from the members full powers to that end, put these resolutions into execution.

The statutes of the original Association, now dissolved, have not been altered. All that has been done has been to add to them an article, 3 bis, in the following terms:

"The Permanent Commission by the written vote of a three-quarters majority of the votes of all its members, decides the countries included in the Association."

As a first manifestation of the resumption of activity on the part of the Association, the Executive Committee will recommence shortly the publication of its monthly *Bulletin*.

The Permanent Commission which will be convoked at an early date will be called on, as a primary duty, to declare itself on the subject of the place and date of the ninth session, at which the statutes in their complete form will be discussed by the plenary assembly with a view to its approval.

Valuable words and signs of encouragement from all quarters have reached the Executive Committee, and the latter has every reason to hope that the "International Railway Association" will continue to pursue with more success than ever the aim which its predecessor assigned to itself: to further the progress of the science and working of railways.

ACTIVITIES OF ENGINEERING COUNCIL*

Engineering Council's Hearing Before National Budget Committee

At the request of the Chairman of the Select Committee on the National Budget, representatives of Engineering Council expressed the opinion of engineers on the subject of a National Budget System, on October 1st, 1919. The invitation was received through the National

* An additional item under this heading on "Structural Laboratory Investigations in Reinforced Concrete", will be found on p. 954.

Service Committee of Engineering Council and its Chairman, M. O. Leighton, M. Am. Soc. C. E., introduced Council's representatives to the Committee. Under the direction of Mr. Charles Whiting Baker, the Chairman of Council's Public Affairs Committee, reasons were given for the general desire among engineers for the adoption of a budget system in the handling of National revenue. He brought out the fact that an important part of Government work is of an engineering nature, which is not being handled with a maximum of efficiency under the present system of appropriating funds, because insufficient financial power is left to the discretion of the director of the work.

Nelson P. Lewis, M. Am. Soc. C. E., Chief Engineer of the Board of Estimate and Apportionment of New York City, explained in considerable detail the efficiencies and economies which have resulted from the operation of the budget system in New York City. He showed that under existing conditions it would be practically impossible for New York City to get along under any other system, and declared that the budget had made an orderliness of administration which could not have been otherwise obtained.

Director and Chief Engineer of United States Reclamation Service, A. P. Davis, M. Am. Soc. C. E., pointed out the necessity of the proper segregation of Government bureaus before an effective budget system can be adopted. As a correct example of segregation, Mr. Davis cited the plan proposed in the Jones-Reavis Bill, whereby all related bureaus having engineering activities would be placed in the same department. Such a plan would simplify and make possible the efficient use of the budget system and of lump-sum appropriation where responsible department heads could be obtained.

Mr. W. R. Warner, of the Warner-Swasey Company, Cleveland, Ohio, pointed out the great advantages that had accrued to private engineering operations through the use of the budget system.

It was pointed out during the hearing that engineering work was particularly hampered by the present system of appropriation. The lump-sum or "continuing contract" method was held to be necessary in many cases. Illustrations of the success of the plan are the Panama Canal, the levee work being done on the Mississippi River, and the large reclamation projects.

Engineering Council Joins Chamber of Commerce of the United States

Engineering Council has been elected to membership in the Chamber of Commerce of the United States. In joining this great association of trade and commercial organizations, Engineering Council adds its strength to organized business and gives its members an opportunity to register their views with the central body in the consideration of National questions that affect business. Engineering Council represents five great National Societies of professional engineers, the Amer-

ican Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Society for Testing Materials. These Societies have an aggregate membership of 41 000.

Engineering Council has just appointed as National Councillor to represent it in the National Chamber and to serve as the connecting link between it and the central organization, Mr. Harold W. Buck, of Viele, Blackwell and Buck, Consulting Engineers, New York City, and Past-President of the American Institute of Electrical Engineers, and, as alternate, Mr. Edwin Ludlow, member of the American Institute of Mining and Metallurgical Engineers.

The Chamber of Commerce of the United States was formed in 1912 as a means of bringing together all the industrial and business elements of the country. How well it has succeeded is shown in a recent statement that its membership now consists of more than 1 100 organizations in every State of the Union, in the outlying possessions, and of all the principal American chambers of commerce abroad.

One of the chief aims of the National Chamber is to obtain the best business thought on National questions that concern business. This is done through a system of referenda on which the more than half a million individual members of the organizations comprising the Chamber are entitled to vote through their associations. The opinion of business, thus obtained, is transmitted to Congress and to public officials and is given to the public.

The National Chamber will be able to render assistance to Engineering Council in many ways. It will receive weekly a general bulletin containing the freshest and most authentic news of what is transpiring in Washington, the city to which all business is looking these days. In addition, there is a special legislative bulletin issued weekly while Congress is in session following the progress of all legislation concerning business. Special bulletins are issued also as occasion arises.

The National Chamber is preparing to erect a building in Washington, D. C., to serve as the permanent National headquarters. This building will be a large and dignified structure, and is designed to commemorate the part taken by American business and industry in the World War. The site selected for this building is at the corner of Connecticut Avenue and H Street, just across Lafayette Square from the White House, the State, War, and Navy and other Government buildings, in the very heart of the Nation's capital. Of dignified classical architecture, the building will be five stories high, and is estimated to cost $2 500 000. Mr. Cass Gilbert, of New York City, is the architect.

Engineers are interested because Engineering Council is a member of the National Chamber, and as such, has the privilege of using all

the facilities of the Chamber's offices in Washington for the benefit of its member societies. The site for the new building has been purchased, and a campaign to raise the remainder of the funds needed is soon to be made. Engineering Council bespeaks the co-operation with the Chamber of such engineers throughout the country as can help. Mr. Harry A. Wheeler, Vice-President of the Union Trust Company, Chicago, Ill., is the Chairman of the Committee on Financing Building.

A National Department of Public Works

At a regular meeting held October 16th, 1919, Engineering Council took the following action in regard to the promotion of a National Department of Public Works:

Conduct of departmental business by the Federal Government is generally admitted to be inefficient and wasteful, for reasons over which departmental officials have no control. Save in notable instances, the conduct of governmental business is markedly inferior to the conduct of private business.

Inefficiency in governmental business is in large degree the result of disorderly groupings of functions, with the resultant lack of rational co-ordination of related activities.

In the administration of the Government's public works, including the engineering and architectural functions, occur the most manifest examples of lack of co-ordination. Public works functions are now scattered widely under many jurisdictions and diversely administered. In some cases, bureaus are competitive instead of co-operative in their interests. With existing conditions, it is impossible to conduct these governmental functions with that efficiency and economy to which the Nation is entitled.

The United States is, with one exception, the only important nation which has not consolidated its public works functions under one departmental authority.

Establishment of a Department of Public Works is a wise and necessary initial step in the correction of these faults of administrative organization.

For the establishment of such a department a bill (S. 2232, H. R. 6649) has been introduced into Congress; this bill is worthy of the support of all citizens and organizations. In view of the above facts, be it

"Resolved, by Engineering Council, representing the American Societies of Civil, Mining and Metallurgical, Mechanical, and Electrical Engineers, and the American Society for Testing Materials, that the Chamber of Commerce, U. S. A., of which Engineering Council is a member, be hereby petitioned to submit the bill for the establishment of a Department of Public Works to referendum in the manner provided by the Chamber's by-laws."

Letter from Chairman Channing

The following is an extract from a letter written by J. Parke Channing, Chairman of Engineering Council, to a member of the Council. It is published, with Mr. Channing's consent:

"On my trip this time I was more than ever impressed with the necessity of continuing the work of Engineering Council. I had been asked to make an address before the Globe-Miami Chapter of the A. A. E. and as I had to spend some time in the district I was pleased to do this. On the evening of November 8th they gave a dinner at which 110 men were present and the subject on which they asked me to address them was National Problems before the Engineering Profession. This, of course, gave me an excellent opportunity to describe what Engineering Council had actually done. My address was received with most intense interest on the part of the audience and some of them told me that it was a great treat for them to hear by word of mouth what was going on and what was being done.

"The local chapter of the A. A. E. was organized soon after F. H. Newell, the President of A. A. E., had made an address in the district. There had previously existed an organization, somewhat larger in topographical extent, called, I think, the Southwestern Society of Engineers, and this has practically bodily gone over to the A. A. E., the various chapters of A. A. E. then being affiliated in a southwestern district.

"A campaign for increased membership is being instituted in the Globe-Miami District, along the line of getting subscriptions for a newspaper and prizes are offered to the individuals who bring in the larger number of recruits. The first prize is a life membership in the A. A. E.

"I noticed that quite a number of the men present that night wore badges of the four Founder Societies, but their enthusiasm was undoubtedly for A. A. E. A telegram was read from Governor Campbell stating that the Arizona delegates in Congress, that is, the two Senators and the members in the House of Representatives, had pledged themselves to vote for the Jones-Reavis bill creating a Department of Public Works. I think undoubtedly the A. A. E. has been the most potent factor in accomplishing this result. Their membership is growing and I believe they predict that by the first of the year they will have 15 000 members.

"What I want to bring out is that this organization is growing and apparently will continue to grow and is liable to be a most important factor in public affairs. Although believing in Democracy as a whole, I know that it has its limits, and I cannot but feel that the older and more experienced members of the profession should be better qualified to deal with public affairs than an organization of this kind, but unless these older and more experienced men get together and work they may be overshadowed by the younger organization."

Special Committee on Highway Engineering

On the recommendation of the Committee on Special Committees, the Board of Direction, at its meeting on June 16th, 1919, decided to appoint a Special Committee on Highway Engineering. The purpose of this Committee is to keep in touch with the development of the Gov-

ernment's plan for the construction and financing of National highways and to advise the Society of these plans and activities by the submission of frequent or periodic reports or critical reviews, accompanied by such data as are necessary to indicate the scope and character of the work in progress from time to time. The members of the Committee are Messrs. H. Eltinge Breed, Chairman, George W. Tillson, and A. B. Fletcher.

Engineering Societies Employment Bureau

The Bureau has issued the following report of its activities during October, 1919:

	Total Last Report.	This Report.	Total to Date.
No. of men registered	4 858	261	5 119
" " " interviewed (estimated).	17 083	1 789	18 872
" " " reported placed	1 000	166	1 166
" " positions registered	1 988	264	2 252
" " " open		395	
" " letters of applications fwd.	15 691	1 952	17 643
" " pieces of mail sent out	19 974	2 156	22 130
Ans. to "Men Available" Ads		157	
Receipts	$13 500.00		$13 500.00
Expenditures	10 601.19	$1 368.78	11 969.97
Unexpended balance	2 898.81		1 530.03

Joint Committee on Culvert Pipe Specifications

This Joint Committee is composed of representatives of the American Concrete Institute, American Society for Testing Materials, American Railway Engineering Association, American Concrete Pipe Association, American Association of State Highway Officials, and the American Society of Civil Engineers. The invitation to the Society to appoint representatives on this Joint Committee came from the American Concrete Pipe Association and the Board of Direction authorized their appointment at its meeting of October 14th, 1919. Messrs. T. L. D. Hadwen and George H. Tinker have been appointed as the representatives of the Society.

Joint Committee to Formulate Specifications for Reinforced Concrete

At the invitation of the American Society for Testing Materials, the Board of Direction, at its meeting of October 14th, 1919, authorized the President to appoint five members to represent the Society on the Joint Committee to Formulate Specifications for Reinforced Concrete, the Committee to select its own Chairman. President Curtis has appointed the following members as such Committee: Messrs. Rudolph P. Miller, Chairman, W. K. Hatt, A. E. Lindau, W. A. Slater, and S. E. Thompson.

Pittsburgh Experiment Station, U. S. Bureau of Mines

The following report was made to the Board of Direction at its meeting of October 14th, 1919, by Robert A. Cummings, M. Am. Soc. C. E., Chairman of the Delegation appointed to represent the Society at the dedication ceremonies of the new buildings of the Pittsburgh Experiment Station of the U. S. Bureau of Mines, at Pittsburgh, Pa., September 29th to 31st, 1919:

"Board of Direction, "Oct. 6th, 1919.
"American Society of Civil Engineers:

"Gentlemen.—Under date of July 2d, I accepted your appointment as Chairman of a delegation of members of the American Society of Civil Engineers, invited to be present at the ceremonies in connection with the dedication of the new buildings of the Pittsburgh Experiment Station of the Bureau of Mines, U. S. Department of the Interior, and respectfully submit my report herewith.

"In response to your instructions, the following Pittsburgh members of the Society, who are particularly interested in the mining industry, were appointed as delegates: Messrs. John M. Rayburn, N. F. Hopkins, W. A. Weldin, Wilbur M. Judd, S. A. Taylor, J. R. Elliott, Lee Llewellyn, George M. Demorest.

"The ceremonies extended over a period of three days, commencing at 8:30 a.m., Monday, September 29th, 1919, by an inspection of the Experiment Station Buildings, at Forbes and Morewood Avenues, Pittsburgh, Pa.

"The U. S. Bureau of Mines was established in 1910, with the late Dr. J. A. Holmes, in whose honored memory the buildings are dedicated, as Director. The province and duty of the U. S. Bureau of Mines, as defined in the legislation creating it, is to conduct scientific and technologic investigations concerning mining and the preparation of mineral substances, with a view to the increase of health, safety, and efficiency in the mineral industries. Its work has two phases: Investigative, to determine the best procedure along these lines; and co-operative, to assist industry in utilizing to the fullest practicable degree the improved practices thus developed. To the latter end, it welcomes the co-operation of operators, workmen's organizations, commercial bodies, technical societies, State and other Government officials, in brief, every one who is interested in the advancement of the mining and metallurgical industry. The organization is divided into two branches:

"The Research Branch has charge of investigative work, which is chiefly carried on in the Experiment Stations, although a large part is performed in the field. For purposes of technical supervision, there are five divisions of the research work; mining, metallurgical, petroleum, mechanical equipment (which includes the utilization of fuel), and mineral technology. The lines of distinction in these five fields will be reasonably clear from the names. The research work of the Mining Division deals chiefly with the causes of mine explosions and the devising of methods for their prevention, the testing and origination of equipment to make mining safer, and of apparatus for rescue and safety work, the study of mining methods preparatory to promoting the use of those that are safest and most efficient, and the

investigation of explosives that are safe and satisfactory for underground work. The Metallurgical Division investigates methods of recovery of metals from their ores, and devises new or improved methods, in order to render available ores which are not now worked and to permit more complete recovery from those which are worked; it also studies the washing of coal. The Mechanical Division cooperates with these two divisions in so far as they deal with mechanical equipment, and more especially with the Mining Division, in the design and operation of safe equipment in underground mining; it also studies the problems of the utilization of fuels to secure better economy and to make available sources of power, like the lignites of the West, which at present are little used. The Petroleum Division investigates the output and utilization of petroleum, in order to prevent unnecessary wastes, both in production and use. The Division of Mineral Technology studies the methods of production and utilization of non-metallic mineral substances, to the same end.

"The Operations Branch carries on the routine co-operative work of the Bureau, which has been initiated by the Research Branch. The Division of Mine Rescue Cars and Stations carries on mine rescue and first-aid work at actual disasters, trains thousands of miners yearly to perform such work, and promotes interest in safety in mining through every means at its command. The Division of Education and Information facilitates the availability to the mining public of the work done by the other branches, through the publication of researches and statistics, exhibits, motion pictures, and the dissemination of information as to the laws governing the mining industry. The other divisions of the Operations Branch are concerned with the routine administration of the Bureau's work.

"The main building contains the Administrative Office of the Station and an auditorium seating 228 persons and equipped with lantern machines, also the offices for the following sections: Coal Mining, Mine Safety, Fuels, Electrical, Mechanical, Chemical and Explosive Sections, Coal and Miscellaneous Analytical Laboratories, Gas Laboratory, Gas-Mask Laboratory, Natural Gas Research Unit, By-Product Coking Research Unit, Microscopic Research Unit, Petroleum Laboratory, Explosives Chemical Laboratory, Metallurgical and Metallographic Laboratories, and Physical Laboratory.

"As part of the Coal Mining Section, there is an experimental mine near Bruceton, Pa., at which field investigations are conducted. The Bureau also carries on co-operative investigations and educational work with State organizations and with the Departments of Mining and Mining Schools of colleges and universities, and with ten other Experiment Stations distributed in the Central and Western States. The National first-aid and mine rescue contests are carried on under the auspices of the Bureau.

"Following the inspection of these extensive facilities, the dedicatory ceremonies were held at 10.30 A.M., at which addresses were delivered by the Mayor of Pittsburgh, the First Assistant Secretary of the Department of the Interior, Governor Sproul, of Pennsylvania, Mr. Channing, of the American Institute of Mining and Metallurgical Engineers, Mr. Bittner, representing the United Mine Workers of America, and by Van H. Manning, Director of the Bureau of Mines, all of whom expressed appreciation and encouragement in the welfare work of this Bureau.

"In the afternoon, an experimental and explosive testing station at Bruceton was visited, and explosions of pulverized Pittsburgh coal dust were witnessed, also demonstrations of the use of liquid oxygen explosions and the dangerous phases of the use of open-flame lamps and electric currents in mining.

"Tuesday, September 30th, was devoted to mine-rescue contests, concluding with an interesting pageant of 'The Hidden Treasures of Earth', the theme of which was the gradual growth through the ages of science as a director of search.

"The ceremonies were concluded on Wednesday, October 1st, with the field contests and the award of prizes.

"The striking feature at these ceremonies was the very laudable and far-seeing plan laid down for scientific and welfare development, which is equally applicable to Civil Engineering. This may be emphasized as the science of engineering and the human advantage of first-aid work.

"Respectfully submitted,
"ROBERT A. CUMMINGS,
"Chairman."

Books Wanted for the Library of the University of Louvain

The following letter has been received from Harrison W. Craver, Secretary of the Library Board of Engineering Societies Library:

"November 18, 1919.

"Dr. CHARLES WARREN HUNT, *Secretary,*
"American Society of Civil Engineers,
"29 West 39th Street,
"New York City.

"DEAR SIR:—An organization has been formed in this country and England to provide a new library for the University of Louvain, to replace that destroyed by the Germans. Contributions of money and books are being solicited for the purpose.

"The Library Board of the Engineering Societies Library has offered a selection of books from its duplicates to the American Committee and these have been gratefully accepted. In the discussion of the question by the Library Board it was suggested that many individual engineers would doubtless be glad to present books to the University, if they knew that they were wanted, and I was instructed to bring the matter to your notice, in the hope that you would call it to the attention of your members, possibly through a note in your periodical.

"Standard books on mining, construction, mechanical engineering, electricity, etc., will be very acceptable. It is not essential that these be the latest editions, although works which are antiquated should not be sent. Sets of the publications of learned and professional societies are especially wanted.

"Books may be sent to the Librarian of Congress, Washington, D. C. The packages should be marked 'For Louvain University'. The Engineering Societies Library will be glad to forward any books sent to it for this purpose.

"Yours very truly,
"HARRISON W. CRAVER,
"Secretary, Library Board."

Programme Committee for Second Meeting of Each Month

At its request, the New York Meetings Committee which was appointed by the Board of Direction at its meeting of April 16th, 1918, to take charge of the programme of papers, addresses, etc., at the meetings of the Society held on the third Wednesday of the month, was discharged with thanks by the Board at its meeting of September 9th, 1919. On the recommendation of that Committee, the Board authorized President Curtis to appoint a new committee to be known as the Programme Committee for Second Meeting of Each Month. The personnel of the new Committee is as follows: Robert Ridgway, Chairman, Chas. Warren Hunt, Paul G. Brown, Herbert M. Hale, and C. Raymond Hulsart.

Permanent Franco-American Engineering Committee is Organized

The Permanent Franco-American Engineering Committee has met and organized by the appointment of Nelson P. Lewis, M. Am. Soc. C. E., as Chairman. Mm. Millerand and Barbet, President and Secretary, respectively, of the Congres General du Genie Civil, have been advised to that effect. The Committee, which is composed of two members of each of the four Founder Societies, is as follows:

Representing the American Society of Civil Engineers: Nelson P. Lewis, George F. Swain.

Representing the American Society of Mechanical Engineers: Charles T. Main, George W. Fuller.

Representing the American Institute of Electrical Engineers: Lewis B. Stillwell, Andrew M. Hunt.

Representing the American Institute of Mining and Metallurgical Engineers: E. G. Spilsbury, Arthur S. Dwight.

Machine Tools for Technical Institutions

The Senate passed a bill providing for distribution of surplus machine tools to educational institutions at 20% of their cost, minus the cost of their delivery. The House passed a separate bill providing for distribution of these same tools at 10% of their cost price, plus transportation charges. The bill as agreed to in conference, provides "That the Secretary of War is authorized under such regulations as he may prescribe, to sell at 15% of their cost * * *. The money realized from the sales may be used by the Secretary of War to defray expenses, except cost of transportation, incident to the distribution of these tools * * *". The Machine Tool Section of the Office of Director of Sales, War Department, is in receipt of a large number of inquiries and tentative orders for these tools. The Section was prepared to make shipments as soon as the bill became law, as it had been anticipated for some time that the measure would pass eventually.

Organization of the Division of Sanitation in the Bureau of Hygiene and Public Health of the League of Red Cross Societies

Professor George C. Whipple, M. Am. Soc. C. E., of Harvard University, has been appointed Director of the Division of Sanitation in the Bureau of Hygiene and Public Health of the League of Red Cross Societies. This announcement comes through Mr. Henry P. Davison, Chairman of the Board of Governors, and Dr. Richard P. Strong, Medical Director of the League. Professor Whipple will at once take up the task of organizing this new and important Division, but will continue his work at Harvard until February, 1920, when he will go to Geneva, Switzerland, the headquarters of the League of Red Cross Societies. He expects to spend several months in the Balkans and the Near East, returning to Harvard in September, 1920.

Col. Francis F. Longley, M. Am. Soc. C. E., is to be the Associate Director of the Division. He will go to Geneva about December 1st, 1919.

Mr. Whipple is Professor of Sanitary Engineering in Harvard University, and Secretary of the School of Public Health in Harvard University and the Massachusetts Institute of Technology. He has held various engineering positions in connection with water supplies and sewerage problems. In 1917, he went to Russia, *via* Japan, China, and Siberia, as Deputy Commissioner and member of the American Red Cross Mission to Russia. During the war, he was also in close touch with the work of the American Red Cross, sending a number of his students to Servia, Greece, Palestine, Guatemala, and other countries. He has thus already had opportunity to study the sanitary needs of many countries.

Col. Longley's experience has been largely in connection with water-works problems. During the recent war, he served as Colonel of the 26th Engineers, and was head of the Water Supply Service of the American armies in France.

It is the intention of Dr. Strong to make the Bureau of Hygiene and Public Health a sort of international health department and a general clearing house for the correlation and exchange of information regarding public health activities in all parts of the world. Obviously, sanitary engineering must play an important part in such a programme. A further statement of detailed plans will be made as soon as the organization has been perfected. It is probable that the directors of most of the other divisions will be chosen from European countries.

Maj.-Gen. Black Retires from Active Service as Chief of Engineers

Maj.-Gen. William M. Black, M. Am. Soc. C. E., Chief of Engineers, U. S. A., was retired from active service on October 31st, 1919, upon his own application, after more than 46 years' service. During

the World War his work with the National Research Council earned for him the Distinguished Service Medal. Col. Francis V. Abbot, M. Am. Soc. C. E., Corps of Engineers, U. S. A., has been detailed temporarily as Acting Chief of Engineers.

Supplemental Estimate of Appropriation Required by U. S. Coast and Geodetic Survey

An estimate in the sum of $65 000 has been submitted by the Department of Commerce to cover further expenses of the Coast and Geodetic Survey, the principal items of which are as follows:

Primary triangulation and signal building to complete about 450 miles of arc, this work to be done along the California-Oregon arc, about 150 miles; Pocatello, Idaho, northward about 150 miles and in Nevada about 150 miles	$25 200
Primary traverse in Mississippi, Alabama, and Georgia	15 000
Precise leveling to complete about 1 890 miles of leveling, this work to be done in California, Oregon, Washington, and Colorado	17 000

The remainder of this appropriation will be required for reconnaissance for primary triangulation and market stations, gravity, station marks, and astronomic work.

The First Deficiency Appropriation Bill, 66th Congress

A number of items of vital importance to engineers were included in the first deficiency appropriation bill. They are as follows: $2 950 000 for the prevention of forest fires; $175 000 for industrial research, industrial safety standards, and standardization of scientific instruments at the Bureau of Standards; $250 000 for repair of naval vessels. The following items were changed in conference: Alaskan Railroad appropriation was reduced from $17 000 000 to $6 000 000; Army Air Service appropriation of $15 000 000 was entirely eliminated, and the appropriations providing for 33⅓% increase of pay for draftsmen in the Navy Hydrographic Office and engineers in the Coast and Geodetic Survey Office were also eliminated. The Alaskan Railroad appropriation was reduced because $6 000 000 is all that will be needed during the current fiscal year, and the balance of the $17 000 000 required to complete the work will probably be made in the next regular Sundry Civil bill. The appropriation for the Army Air Service was eliminated because it was contemplated that this Service will be cared for in the future by a regular appropriation bill covering this special subject. The total amount appropriated under the provisions of the first deficiency appropriation bill was $29 461 035.85. This is a reduction of almost 50% from the bill originally passed by the Senate.

CONTRIBUTIONS FROM THE ENGINEERS', ARCHITECTS', AND CONSTRUCTORS' CONFERENCE ON NATIONAL PUBLIC WORKS

Explanation of Important Features of the Jones-Reavis Bill to Create a National Department of Public Works*

Significance of the Name "Public Works".—The name "Department of Public Works" leads to misconception of the scope of this organization's work. "Public Works" is a poor name but it, or its equivalent in other languages, has been adopted all over the world to embrace tangible property owned by Government or that over which Government has direct sovereign jurisdiction, together with all official functions and activities related thereto and necessary to public utility. There can be no fixed and comprehensive definition of public works because that which may be considered a part of public works in one country may be altogether lacking in such qualifications in another. The Jones-Reavis Bill fails to propose public works jurisdiction over several Government properties or activities which, under strict construction of the definition, should be included. Conversely, it includes certain Government bureaus, certain parts of which may not appropriately fall under a Public Works Department but which, at present, and pending reorganization, are so inextricably interwoven with purely public works functions that their separation is not now regarded as expedient. Because of this it appears desirable to explain many points in the "Jones-Reavis Bill" which have puzzled readers who are not in touch with the legislative and departmental situation in Washington.

Why Do we Propose to Transform the Department of the Interior Instead of Creating a New One? (See Section 1 of the Bill).—Because (*a*) there are already enough Executive Departments to perform Government business if the functions were properly co-related; (*b*) because there is a natural reluctance on the part of Congress to create new Departments, which of itself would be an enormous handicap to any public works legislation.

Why Do we Propose that the Present Secretary of the Interior shall Continue as Secretary of Public Works until He shall go out of Office? (See Section 1 of the Bill).—Because the present Secretary is a very able man, and he has had more than seven years of intensive training in the administration of that office.

Why Do we Propose to Maintain in the Present Organization of the Interior Department and its Bureaus, except those Designated for Separation and Transfer, Other Bureaus from Other Departments Thereto without Change of Organization? (See Sections 2, 3, 4, and 6 of the Bill).—Because (*a*) no one is wise enough at present to make

* Received from Engineers', Architects', and Constructors' Conference on National Public Works, M. O. Leighton, Chairman.

a decision as to the best reorganization plan; (*b*) because the best reorganization will be that achieved gradually as the result of experience within the new Department; (*c*) because a large degree of reorganization can lawfully be made by Executive Order; (*d*) because when, after experience has been secured, special reorganization legislation becomes necessary, a bill can be presented to Congress reinforced by such experience and have the prestige of a going Department behind it.

What Remains in the Department of the Interior as a Nucleus of the Department of Public Works after the Six Bureaus Designated in Section 3 of the Bill Have Been Removed?—The General Land Office, Geological Survey, Reclamation Service, Bureau of Mines, National Park Service, and Alaskan Engineering Commission.

Why Do we Propose to Assign the Various Non-Engineering Bureaus of the Interior Department to the Places Designated in the Bill? (See Section 3).—We do not claim to have any particular qualifications that enable us to choose the wisest assignments of those bureaus. We were obliged to put them somewhere in order to "round out" the Bill, and we used our best judgment. Others, better qualified than we, will undoubtedly have something to say when the bill comes to consideration in Committee of Congress.

Why Do we Propose to Divide Control of the Duties of the Office of Indian Affairs? (See Section 3 of the Bill).—The main purpose of the Office of Indian Affairs is to educate the American Indian who is now a ward of the Nation, provide for his social welfare, and eventually create citizens. Therefore, the principal functions of this Office fall under the branches of education and labor. When these objects are accomplished the Office of Indian Affairs will automatically go out of existence. The greatest and most important engineering work connected with this office, namely, the construction of irrigation systems, is now and has for many years been performed by the Reclamation Service. Therefore, the proposal to divide the functions, as set down in Section 3 of the Bill, does little more than to continue a very advantageous arrangement already in effect. The only other important construction falling under the Office of Indian Affairs is that of Indian schools, houses, etc., which is now performed directly by that Office. There can be no question that with a co-ordination of public building operations, as proposed by the "Jones-Reavis Bill", construction of Indian Office buildings by that Bureau would make for efficiency and economy, and such a plan would be merely a copy of that which has been in existence for many years, and under which post-office buildings, court houses, custom houses, etc., have been constructed by the Supervising Architect.

Why Do we Propose to Transfer the Jurisdiction over Rivers and Harbors from the War Department? (See Section 4 of the Bill).—Because, entirely aside from the decidedly adverse opinions that the

great body of engineers entertains as to the fitness of the Corps of Engineers, U. S. A., and its past performances, rivers and harbors improvements for navigation constitute a purely civil function which is merely one phase of our rivers and harbors development and utilization, and the whole cannot go forward effectively, considerately, and economically without thorough co-ordination. Navigation improvements are public works and are so defined the world over, and the fact that in an early day in the history of our Republic they were placed under the Corps of Engineers, as a purely emergency measure, which has since been continued by well directed influence and legislative inertia, constitutes not the slightest reason why an illogical arrangement should be perpetuated.

Why Do we Propose that Members of the Corps of Engineers, U. S. Army, Should Be Detailed to Duty under the Department of Public Works? (*See Section 4*).—Because the members of the Corps of Engineers rightfully contend (and this is the only substantial argument so far brought forward by the Corps against a Department of Public Works) that the Army must maintain an Engineer Corps on a basis suitable for war emergency; that so large a Corps will not be required on purely military duties in peace time, and that, in the absence of some engineering assignments of another character, the Corps of Engineers will "rust out". The provision in the bill, therefore, provides for this contingency. It places the engineers in the Army under assignments suitable for their training and experience and makes no change in their professional status, except that it establishes the principle, which appears to be good American doctrine, that because a certain group of men is educated at public expense and accorded military titles, it does not follow that they must become hereditary superiors to other men in engineering life. The members of the Corps of Engineers in their civilian work would, under the provisions of this bill, stand on a common footing with civilian engineers and indulge in a very healthful competition for relative position in the engineering work of the Government, and attain such by reason of actual performance rather than by seniority in military grade.

Why Do we Propose to Include the Construction Division of the Army in the Department of Public Works? (*See Section 4*).—Because (*a*) this division is made up almost entirely of civilian engineers highly experienced in construction work who have, in connection with the war emergency, performed the most extensive and remarkable achievements in engineering construction ever performed by any one organization in the history of the country; (*b*) because it has worked out a most effective plan of organization and operation which is in a large degree responsible for the results achieved and which could be amalgamated most efficiently with many of the peace-time construction operations of the Government; (*c*) because the War Department has not provided for

the perpetuation of this organization, as such, in its plan for a new military establishment, which is now the subject of investigation by Congress, and, at least by inference, proposes to allow the Construction Division to lapse or to merge its functions with certain old-line military departments where it will be in an environment entirely foreign to the spirit and practice which has caused it to be so unqualified a success; (*d*) because the construction work which this Division has accomplished is, for the most part, not military engineering at all, and the only military significance which it has is derived from the subsequent utilization thereof for military purposes. There is no more reason why the construction of a warehouse, a depot, or a dock for the Army cannot be executed by an established construction organization not connected with the Army, than there is for the contention that a Federal courthouse should be constructed by the Department of Justice instead of, as in the past, by the Supervising Architect's Office of the Treasury; (*e*) because when the United States entered the great war it was necessary to organize the Construction Division under an extreme emergency attended by costly delay, and there should be an active going construction organization in the service of the Government, which, in the case of a future war, could be made to function at an instant's notice as a construction branch of the military establishment. The only way by which this can be accomplished is to have such an organization in active practice in peace-time work.

What is the Reason for Including the Forest Service in the Department of Public Works?—While it is true that the science of forestry, so far as its sylvicultural aspects are concerned, is an agricultural science, the real problems of operation and maintenance of a National Forest as they occur under the conditions prevailing in this country are more truly related to engineering than to agriculture. In the first place, forest reserves are unquestionably public works. They are properties owned by the Government and set apart for public purposes. The harvesting of lumber, fire prevention, the construction of roads and trails, the conservation of water, and the administration of water powers are unquestionably engineering operations. There is yet a third phase of the subject which is perhaps more important than the other two from the standpoint of efficient public administration. The Jones-Reavis Bill retains within the proposed Department of Public Works certain bureaus of the Interior Department which have largely to do with public lands. These are the General Land Office, the Geological Survey, the National Park Service, the Reclamation Service, and the Bureau of Mines. These Services are concerned in a more or less intimate way with public land boundaries, surveys, and the classification of the land for one or another purpose under the public land laws. It is of unquestionable advantage and productive of large economies to have these bureaus under one roof. The Forest Service, however, has quite as

intensive relation to public land matters as has any of the other bureaus previously mentioned, indeed, a far more intimate relation in many respects. Therefore, in view of the multiplicity of engineering functions necessarily comprised in the administration of forest reserves, together with the obvious public advantage of co-ordination in land administration, there seems to be no question that distinct public advantage could be gained by including the Forest Service into the Department of Public Works, notwithstanding the fact that one of the important functions of such a service is pure forestry.

What is the Explanation of Section 7 of the Bill Providing for Four Assistant Secretaries with Jurisdiction Defined?—Much doubt has been expressed as to the ability of the Government to secure qualified men to accept these positions of Assistant Secretary at a compensation of $7 500 per annum. It is admitted that such compensation is inadequate, but the figure was determined on with full recognition of present legislative expediency. A compensation of $7 500 per annum is about 50% greater than the present average salary of the Assistant Secretaries of Federal Departments. A proposal to increase the amount over that set down in the Bill would result in great objection and endless debate, and grievously endanger the adoption of the measure. If, after the establishment of the new Department, it is found that qualified men cannot be secured at the compensation named, an adjustment can be made by Congress with far greater facility than could possibly be done at present. The important object of the proposed legislation is to secure the adoption of the principle, and details as to compensation and organization should be postponed so far as possible, in order that they shall not complicate the main question. A saving factor is provided in that these Assistant Secretaries shall be included within the scope of Civil Service retirement laws. Such laws have been advocated for nearly a generation, and the principle constantly gains strength. Undoubtedly, some suitable law will be enacted in the near future. Properly qualified men will in many cases be content with moderate compensation during active life, provided they are assured of suitable retirement pay after they have become superannuated. We are familiar with many notable examples in the Army and Navy. Every man who enters these two branches of the service faces a life of moderate income supplemented by retirement pay. This has attracted and will in the future attract good men who recognize that in practically every other walk of life there can be no certainty of income, either large or small.

Some good friends of this cause have questioned the plan in Section 7 concerning the assignment of duties to Assistant Secretaries according to the character of the work. They contend that if the work of any one Bureau should involve all the functions designated in the section, that is, engineering, architectural, surveys, and law, said Bureau would have four commanding officers instead of one, and confusion and loss

of efficiency would result. This criticism is a result of misconception of the language. These Assistant Secretaries will not be chiefs of bureaus, but merely arms of the Secretary of Public Works. The chief of any bureau will, as at present, have executive authority over all the operations of his bureau. His ultimate superior will be in all cases the Secretary of the Department of Public Works. Were it possible to secure an omnipotent person as head of the Department, Assistant Secretaries would not be necessary, but as at present the world is not producing omnipotent men, it is necessary to give a Secretary of Public Works the advantage of specialized brains. The four Assistant Secretaries proposed are in effect merely additional lobes of the Secretary's brain and are a part of his official entity. Instead of reporting to an individual, as is done under the present practice, the bureau chief will report to and take counsel of a superman.

Engineers in the Pan American Financial Conference

Those in charge of the Second Pan American Financial Conference state that the Engineering Profession will be well represented at the January conference to be held in Washington. Latin-American engineers are more closely connected with important industrial projects and have a greater command in matters pertaining to the developments on which they are working than is the case in the United States. Our own Engineering Profession, therefore, may do well to study into the Latin-American plan of co-operation between capital and the engineer. The former Assistant Director of the Bureau of Foreign and Domestic Commerce has gone to Central America to get definite data on the credit and investment requirements of Latin America. These data are for the special use of the conference.

Legislation to Investigate and Prevent Fires and Dust Explosions

Further duplication in departmental functions is now proposed in a bill (S. 2920) just introduced in the Senate to appropriate the sum of $100 000 to the Department of Agriculture for the purpose of investigating causes of fires and dust explosions in cotton gins, grain mills, elevators, warehouses, etc. Co-operation of the State officials and manufacturers is sought, and practical means of prevention are to be recommended by the Department. This is an excellent plan, but it should be remembered that authority has long since been possessed by the Bureau of Mines to do this work, and that Bureau has been able to make comprehensive recommendations to improve conditions. The Bureau of Mines knows how. Now, because the subject of investigation happens to be an organic instead of an inorganic dust, it is proposed that another Department shall set up a special investigation and go over much of the old ground again.

Geology and Ground-Waters of San Diego County, California

The U. S. Geological Survey has published *Water Supply, Paper No. 446,* entitled, "Ground Water Hydrology: Geology and Ground Waters of the Western Part of San Diego County, California", by Arthur J. Ellis and Charles H. Lee, M. Am. Soc. C. E.

The portion of this report prepared by Mr. Lee, who is the Executive Member of the State Water Commission of California, treats of the ground-water hydrology of the shallow water-bearing formations of the Pacific Slope of San Diego County, and the utilization of ground-water from these formations. Complete precipitation records at 106 stations are presented, together with a detailed map of the county, with lines of equal precipitation at 2-in. intervals. Interesting conclusions are drawn regarding the quantity of rainfall in any season necessary to produce run-off and also the relation of rainfall to run-off. Evaporation observations are given, and comparison is made between evaporation from a pan floating on a large reservoir surface, and the reservoir surface itself, which indicate that there is little difference between the two. Data regarding soil evaporation and transpiration from mixed natural vegetation are also given.

Detailed physical descriptions are made of the ten largest underground reservoirs of the region lying in the principal river valleys, with numerous well logs, geologic sections, records of well fluctuation, ground-water profiles, and estimates of average and safe yield based on the "water table" method. The tests of the yield of individual wells are also presented. The conclusion is drawn that ground-water in the San Diego County river valleys has very little movement and seldom occurs as underground streams, but occupies underground reservoirs.

Similar data are presented for underground reservoirs of the minor coastal plain and highland valleys, the sea terraces adjacent to San Diego Bay, and the decomposed granite areas of the highland.

Tests of existing pumping plants of various types are presented, which for working conditions on the farm, show pump and pumping plant efficiency and the cost of pumping for irrigation. The selection and installation of pumping machinery is also discussed.

Road Building Outlook for 1920

A total of $633 000 000 is now in sight for road-building purposes during 1920. The Bureau of Roads arrives at this estimated total expenditure, as follows: brought forward from unfinished work, $165 000 000; available from State and county taxes and Federal aid, $273 000 000; one-fifth State and county bond issues not before available, $50 000 000; one-third unexpended balance of State and county bond issues, previously available, $45 000 000; available from new bond issues to be voted on during the remainder of 1919 and early part of

1920, $100 000 000. The United States Geological Survey will assist the Bureau of Roads by helping to stimulate the production of road-building material, if it can obtain the funds that will be required for this purpose. It has now become apparent that unless greatly increased production of road-building material is secured in the near future, full advantage of transportation facilities as well as the funds that are available cannot be had. According to the records of the Bureau of Roads each month breaks the record of new roads started and completed under the extensive road-building campaign of the State and Federal Government.

Technical News Bulletin No. 31

In *Technical News Bulletin No. 31,* issued November 5th, 1919, the Bureau of Standards has compiled a short description of its results on the following work: Principles of Radio Transmission and Reception with Antenna and Coil Aerials; Tests of Telephone Receivers for Radio Use; Investigation of Corrosion Cables in St. Louis; Tests of Reinforced Concrete Floor Slabs; Durability of Cement Drain Tile in Alkali Soil; Effect of Cal and Calcium Chloride on the Strength of Concrete; Discoloration Tests of Limestone; Increasing the Speed and Color Sensitiveness of Photographic Plates; Photographing through Haze and Smoke, etc.

Experimental Work on Oil Shales

Because of the enormous quantity of oil tied up in the great shale deposits of the United States, it has been the opinion of many engineers that the recovery of the oil can be profitably undertaken. A bill has been introduced in the Senate proposing to provide the Bureau of Mines with $140 000 for experimental work on oil shales. The Secretary of the Interior has advised the Senate Committee on Mines and Mining that the plan for the proposed research work is necessary to ascertain the most profitable way of recovering the oil. The bill has his complete approval.

A large initial outlay of capital will be necessary in any projects organized to get commercial oil in this way, because an extensive manufacturing process is involved. The importance of accurate and extensive preliminary research work is therefore apparent. This source of petroleum supply will be of added value to the country when the point is reached where oil wells do not produce sufficiently to meet all requirements. One item of great importance which must be looked to in the future is the increasing tendency to use oil in high-power naval craft. It is contemplated that a supplemental appropriation of about $70 000 per annum will be required to carry on the necessary research work.

Publicity Desired for the National Department of Public Works Campaign

Under date of Washington, D. C., September 24th, 1919, the Society has received the following communication, signed by M. O. Leighton, M. Am. Soc. C. E., Chairman, and C. T. Chenery, Secretary, of the Engineers', Architects' and Constructors' Conference on National Public works:

"Your Society doubtless has members who are rather constantly on the move throughout the country on behalf of the interest of the Society or public matters which would bring them in touch with considerable groups of people. If these men can be gotten to make references to the National Public Works campaign in such addresses or speeches as they might make it would be a very helpful activity. We cannot begin to give the publicity to this matter which it requires, and are therefore calling on the Societies for aid and counsel. If you can arrange for any of your members to help in the way which we have outlined or in any other way which you may suggest, we can furnish them full information on which to base their talks and in as complete a form as they may desire.

"If we are to succeed in this attempt to create a National Department of Public Works it will be because engineers as a whole take an active interest and part in this campaign. Unless such an interest and such a participation can be secured, the measure is doomed to failure.

"The wider we can spread the gospel and the more publicity we can get for it, the better are our chances of enlisting the full support of the profession. If the four Founder Societies put their shoulders to the wheel a general speeding up of the entire programme will result."

National Motor Truck Shows and Highway Transport Conferences

The Motor Truck Sections of the 20th Annual Automobile Shows of 1920, to be held in the 8th Coast Artillery Armory, New York City, from January 3d to 10th, 1920, and in the International Amphitheatre, Chicago, Ill., from January 24th to 31st, 1920, will be the largest and most comprehensive exhibition of the kind ever held. Approximately 125 000 sq. ft. of exhibition space has been allotted at each place, and upward of seventy makes of motor trucks, together with trailers, parts, and accessories will be displayed. The gigantic size of each building permits exhibitors to show complete lines of models and bodies, which heretofore has not been possible.

In conjunction with these great motor truck expositions, Highway Transport Conferences will be held, with daily afternoon and evening sessions. Every important phase of highway transportation will be discussed by men recognized as qualified authorities on the subject.

Various talks will be illustrated by motion pictures and stereopticon slides. There will be much of interest for those concerned as motor truck owners and operators and, in a broader sense, those who merely have products and goods to ship. The place of the motor truck in the trinity of transportation—railways, waterways, and highways—will be defined accurately and authoritatively.

Manufacturers, distributors, and business men are invited to attend these shows and conferences, and tickets will be sent on application, each ticket bearing the name of the person using it. Members of the Society may apply directly for complimentary tickets to S. A. Miles, Manager, 7 East 42d Street, New York City.

Highway Legislation

The object of the Townsend National Highways Bill, recently introduced in the Senate, is to establish and maintain a National system of highways according to a National plan connecting the different States of the Union and affording an example of proper highway construction which will be beneficial to the States. This work will be directed by a Federal Commission which will make reports annually to Congress as to what is being accomplished. Both the construction of National highways and the operation of the Federal Aid to Good Roads Act will come under the direction of this Commission.

Senator Townsend has been asked what effect the proposed legislation will have on the Federal State Aid Law, and he has stated that there will be no conflict in the execution of these laws and that both should run along in their own channels, except that the Federal Aid Law will be transferred from the jurisdiction of the Department of Agriculture to the jurisdiction of the Federal Highway Commission. It is Mr. Townsend's intention to have the commission appointed under the new law composed of high grade men, representing different sections of the country, who have had ample experience in road construction work.

One of the reasons for the recent setback in road construction work under the Federal Aid Law is the decision of the Judge Advocate General and the Secretary of War not to turn over more motor equipment to the States for their construction work. The Military Affairs Committee has just completed a hearing and perfected a bill giving authority to turn over this material promptly. The new bill is worded so that existing difficulties between the War Department, the Department of Agriculture and the State Commissions have been ironed out, and it is contemplated that, as soon as this legislation can be passed, the material will be promptly made available for road construction work.

Some States, especially through the South, have been greatly hindered in their road-building work, due to the lack of freight cars to transport their road-building material and equipment.

Technical Men for the Consular Service

For the coming consular examinations the officials of the State Department have expressed the hope that a considerable number of technical men will take the examination. The Department recognizes that the interests of the United States will be served best if technical men are made available through these examinations for vacancies at points where their training will be of special value.

The salaries in this service have been notoriously unattractive, and the Department recognizes that the salary scale is more inadequate now than it ever has been, as a result of which the United States has lost much prestige in many communities where properly qualified Americans cannot be induced to accept positions. The Department now wants retired engineers and other technical men who are in a position to put something into the service to take these consular examinations in which they can undoubtedly qualify for the best positions obtainable.

Industrial engineers who passed the consular examinations would be assigned to industrial centers of Europe or South America. Mining engineers, chemists, electrical engineers, etc., would be assigned to industrial centers requiring special training. The consular examinations will be held in the late fall or early winter. No definite date has been fixed as yet.

Individual Responsibility on the Part of Voters Urged to Solve National Problems

Personal responsibility on the part of voters was the keynote of an address made on September 18th, 1919, at the International Chautauqua Conference on Democracy and Reconstruction, at Chicago, Ill., by John T. Pratt of New York, Chairman of the National Budget Committee. Mr. Pratt pointed out that problems centering about the high cost of living, the League of Nations, and other questions of the day, could be solved more readily if voters took a more active interest in National affairs.

As a medium through which National economy and thrift may be assured, Mr. Pratt dwelt on the necessity for a National Budget System. Consideration of such system has been delegated to select committees of the House and Senate, which are expected to report on six budget bills and five resolutions early this winter.

Mr. Pratt stated that the Chief Executive of the nation should be responsible for the annual estimates of expense made by the various departments of Government. He said that these estimates should be drawn up by a Bureau of the Budget, a permanent body of experts, who would confer with department heads before allotting appropriations. An Accounting Department, wholly responsible to Congress, should be given power of audit of all funds appropriated, he added.

American Engineering Standards Committee

At a meeting of the American Engineering Standards Committee held in the Engineering Societies Building on September 18th, 1919, the following resolutions were adopted and the Secretary was instructed to take the necessary steps to put them into effect:

Whereas: An invitation dated June 5th, 1919, has been received from the British Engineering Standards Association requesting the American Engineering Standards Committee to arrange for a conference on the Standardization and Unification of Screw Threads in Great Britain and the United States of America, and with this object asking the American Engineering Standards Committee to bring the matter before the National Screw Thread Commission now sitting in America, and in due course communicate the result to the British Engineering Standards Association; and

Whereas: The National Screw Thread Commission through its Chairman, Dr. S. W. Stratton, has expressed its willingness to co-operate in every possible way with the American Engineering Standards Committee, be it

Resolved: First, that the American Engineering Standards Committee accept the invitation of the British Engineering Standards Association, and that the Secretary be instructed to inform that Association of this action and to express the hope that this co-operation may lead to a universal agreement on this subject.

Resolved: Second, that to this end, The American Society of Mechanical Engineers and the Society of Automotive Engineers be requested to act as Joint Sponsor Societies and organize a Sectional Committee on the Standardization and Unification of Screw Threads, to confer with the National Screw Thread Commission now sitting in the United States, and finally to communicate the result to the American Engineering Standards Committee.

Railroad Statistics

The railroads have at last shown a net gain to the Government. The operating results for July, 1919, of practically all Class 1 railroads and terminal companies under Federal operation indicate that this net gain will run to approximately $2 000 000. The net operating income for July, 1919, was about $77 000 000. The indicated net gain to the Government for July is obtained after allowing one-twelfth of the annual rental due the railroads. The net loss to July 31st, 1919, was $290 526 307. The falling off in freight business, as compared with 1918 and 1917, continues to be an important factor, but July, 1919, shows a slight improvement over June, in the actual business handled. The percentage of decrease compared with the same month of 1918 and 1917 is also less than in June. The preliminary reports on passenger traffic during July indicate a substantial increase over June, 1918, which practically offsets the decrease in freight traffic.

New Jersey Ship Canal Project Is Endorsed

At the monthly meeting of the Chamber of Commerce of the State of New York on November 6th, 1919, the Chamber went on record as favoring the construction of a sea-level canal across the State of New Jersey from Morgan, on Raritan Bay, to Bordentown, on the Delaware River, as a great benefit to New York through the linking together of inland waterways and resultant economies. The Chamber adopted a resolution to this effect, which was presented by Delos W. Cooke, Chairman of the Committee on Internal Trade and Improvements of the Chamber, after sharp debate and opposition.

The Chairman of the New York-New Jersey Port and Harbor Development Commission has stated that, "with this canal dug, with the Chesapeake and Delaware Canal improved by the Government, it will be possible to conduct navigation on inland waters from Norfolk, Newport News, Baltimore, and other ports on Chesapeake Bay to Philadelphia and the port of the Delaware Bay and River, to the Port of New York, thence through the New York State Barge Canal to the Great Lakes; or from the Port of New York through Long Island Sound, and the Cape Cod Canal to the Port of Boston, all in protected waters. The distance from Philadelphia to New York by water at the present time, for vessels drawing more than 7 ft., is 274 miles. The distance *via* the proposed canal would be 87 miles."

Cuban National Census Board Includes an Engineer

In a new Census Law, recently promulgated in Cuba, all operations are supervised, appointments of the principal officers are recommended, and all others approved, by a National Census Board, provided for in the Law.

On account of political agitation in the country, and due to the fact that new electoral lists were to be made part of the work, it was considered necessary to have all Census operations free from political partisanship or Government influence. The Board was to be composed of three members as follows: one, to be the president, from the Supreme Court of Justice; another from the National University of Havana; and the other from the "Sociedad Cubana de Ingenieros", a National engineering society, each of these members to be elected by his respective association.

The resident members of the Engineering Society at a special meeting elected Francisco Gaston, Assoc. M. Am. Soc. C. E., as their representative on the Board. Mr. Gaston is a Civil Engineer, a graduate, in 1902 of the University of Notre Dame, at Notre Dame, Ind. Most of his work has been for the Public Works Department of Cuba, and he has contributed largely to the activities of the Engineering Society and its monthly *Review*.

Structural Laboratory Investigations in Reinforced Concrete

The Concrete Ship Section of the Emergency Fleet Corporation carried on a very extensive series of tests on reinforced concrete, which were subsequently carried further by the U. S. Bureau of Standards. A comprehensive digest of the results of these investigations has been given in the *Proceedings* of the American Concrete Institute, Vol. 15, 1919. On noting the importance of this research work, the National Service Committee of Engineering Council asked the Director of the Bureau of Standards what the prospects were of having this entire line of research analyzed, reported, and printed for distribution, as the matter appeared to be one of exceeding importance to the Engineering Profession. The Bureau of Standards has just advised that it desires to have this investigation fully reported for the benefit of the Engineering Profession, and has assured Engineering Council that the work will be pushed as much as possible.

Engineers Give a Dinner to Herbert C. Hoover

To celebrate his home-coming after his strenuous labors as Commissioner for Relief in Belgium and other wartime activities, a reception and dinner was given to Herbert Clark Hoover, M. Am. Soc. C. E., by 1 200 engineers at the Hotel Waldorf-Astoria, New York City, on the evening of September 16th, 1919.

The invitations were issued by the American Institute of Mining and Metallurgical Engineers, of which Mr. Hoover is a member. Mr. Edward B. Sturgis was Chairman of the Dinner Committee and Mr. B. B. Thayer was Chairman of the Reception Committee.

Mr. Hoover has accepted the nomination to the Presidency of the American Society of Mining and Metallurgical Engineers.

American Association for the Advancement of Science

The American Association for the Advancement of Science and many National scientific societies affiliated with it, will hold its 72d meeting in St. Louis, Mo., from December 29th, 1919, to January 3d, 1920, under the auspices of the Washington University and other educational institutions of the city. Dr. Simon Flexner, of the Rockefeller Institute for Medical Research, will preside. The address of the retiring president will be given by Dr. John Merle Coulter, of the University of Chicago, at the opening general session of the Association. This meeting of the Association, which was established in 1848, will be marked by a programme devoted very largely to definite working problems of reconstruction.

New York–New Jersey Vehicular Tunnel

An interstate treaty providing for the construction of the $12 000 000 vehicular tunnel under the Hudson River, was signed in New York City on September 27th, 1919, by the Bridge and Tunnel Commissions of New York and New Jersey. Engineering staffs are already at work on plans for the tube, the two States having appropriated $1 000 000 each for preliminary work.

The contract just signed is substantially that prepared under the supervision of the New York State Commission and submitted to the New Jersey Commission last May. This contract was required by an act of the Legislature.

It provides for the joint construction, operation, repair, and maintenance of the tunnel, subject to appropriations to be made from time to time by the Legislatures of the two States. No franchise or right can be given to a public service corporation to operate trolleys or subway lines through the tunnel except with the approval of the Governors and Legislatures of the two States. In the event that either State shall attempt to tax the income arriving from the operation of the tunnel or the property acquired in its construction, that tax is to be paid out of the share of the tolls which may be due or owing to the State levying the tax. The title of the tunnel is to be in the States jointly.

A default clause in the contract empowers either State to complete the tunnel and collect the tolls on both sides of the river until it has been reimbursed to the full amount of its expenditures, including interest. The inclusion of such a clause was deemed necessary, for the reason that neither State is obligated beyond the appropriations that may be made from time to time by the Legislatures, and, so far, each has provided but $1 000 000, without a contractual requirement to provide further funds.

The contract also provides that either State may submit it to the Congress of the United States for ratification.

The New York State Bridge and Tunnel Commission includes Gen. George R. Dyer, Chairman; E. W. Bloomingdale, Vice-Chairman; McDougall Hawkes, A. J. Shamberg, Grover A. Whalen, Commissioner of Plants and Structures, and Frank M. Williams, State Engineer and Surveyor. Morris M. Frohlich is Secretary and Paul Windels, 27 Pine Street, New York City, Counsel.

The personnel of the New Jersey Interstate Bridge and Tunnel Commission comprises Weller H. Noyes, Chairman; Samuel T. French, Vice-Chairman; Palmer Campbell, T. Albeus Adams, Theodore Boettger, Thomas J. S. Barlow, Daniel F. Hendrickson, Richard T. Collings and E. Morgan Barradale, Secretary. Counsel to the New Jersey Commission is former Senator Emerson L. Richards, of Atlantic City, N. J.

Investigation of Fatigue of Metals

An investigation of fatigue phenomena in metals under repeated stress has just been started under the joint auspices of the National Research Council, Engineering Foundation, and the Engineering Experiment Station of the University of Illinois. The Engineering Foundation is providing $15 000 for two years for this investigation, and the Engineering Division of the National Research Council is acting in an advisory capacity, largely through its Committee on Fatigue Phenomena in Metals. The experimental work is being done in the laboratories of the Engineering Experiment Station of the University of Illinois, under the immediate direction of Prof. H. F. Moore, Research Professor of Engineering Materials and Chairman of the Committee mentioned. Plans are laid for a two years' programme of tests, and apparatus and material are already arriving. It is hoped to secure considerable data on tests of various metals, including a number of tests of each metal to 100 000 000 reversals of stress. It is hoped to study the various short-time physical tests which are used for metals, such as, the impact test, magnetic analysis, and short-time bending tests, to see whether any of them give reliable indices of the ability of the metal to resist fatigue under millions of repetitions of low stress. It is hoped that some reliable commercial test for this important property may be developed by this investigation. A test party of four or five persons is being organized, and the University of Illinois is fitting up a special laboratory with about 2 500 sq. ft. of floor space for the use of this investigation.

Fellowships in Highway Engineering

The University of Michigan offers two fellowships in Highway Engineering, as follows:

The Detroit Edison Fellowship in Highway Engineering which has been renewed after suspension during the war. This fellowship is the gift of the Detroit Edison Company and pays the holder $500 per year with an allowance of $100 for expenses. The subject to be investigated is Moderate-Cost Country Roads.

The R. C. Chapin Fellowship in Highway Engineering which is also renewed following suspension during the war. This fellowship was given by Mr. R. D. Chapin, of Detroit, Mich., President of the Hudson Motor Car Company and is offered to provide for the study of Hard-Surface Roads and Pavements. It pays $500 per year with $100 for expenses.

A Fellow must have a Bachelor's Degree in Civil Engineering from a college of recognized standing, he must enroll as a candidate for the degree of Master of Science in Engineering, and be in residence at the University for eight months.

American Concrete Pipe Association

The Annual Convention of the American Concrete Pipe Association will be held at Chicago, Ill., on February 20th and 21st, 1920. Sectional meetings are to be held in committee rooms of the Great Northern Hotel, but the main Convention will assemble in the lecture room of the Western Society of Engineers, Monadnock Building, across the street from the Great Northern. One section of the Convention will be subdivided into the three main groups represented in the Association—drain tile, reinforced pipe and sewer pipe. The annual dinner and entertainment will take place at the Great Northern Hotel on Friday evening, February 20th.

A New Arabian Railway

A railway from Aden, the principal port in Arabia, to Laby, the capital of the Abdali Tribe in Southwestern Arabia, has recently been opened. It is 30 miles long and was built by British engineers, the first 4 miles having been constructed under shell fire by the Turks. It is now opened for passenger and freight traffic, and one train per day each way is operated and the road is well patronized. It is said to take the place of 500 camels.

EUROPEAN NOTES

The following notes relative to reconstruction, etc., in Belgium and France, and industrial progress, etc., in Great Britain and elsewhere, have been contributed by W. E. Woolley, Assoc. M. Am. Soc. C. E., of London, England, who is also a Corresponding Member of the Association of Liége (Belgium) Architects.

Engineers and Architects Co-Operate to Revive Agriculture in Belgium

Great efforts are being made to revive agriculture in Belgium. Belgian engineers and architects helped to organize an important exhibition held at the Palais d'Egmont, Brussels, in September, 1919, with the assistance of the Belgian Ministry of Agriculture, which was followed by an important conference. Agricultural work during the war was dealt with, as well as its reconstruction. Models and plans of various types of farm and country houses were shown, which were considered suitable to improve and revive agriculture, and proper drainage, sewerage, and sanitation were also dealt with. It appears that during the war many farmhouses were erected and farms formed. Each Belgian Province participated in the Exhibition.

The Damage and the Work of Reconstruction in the Province of Hainaut, Belgium

L'Indépendance Belge, of recent date states, that one is forced to acknowledge that an enormous effort has been attempted, and that considerable work, realized in a time relatively short, has permitted the amelioration, in a surprising fashion, of the condition of Hainaut Province, Belgium.

The roads and railways were submitted during the German occupation to a tremendous military traffic, and the retreat of the German bands, September-October, 1918, multiplied in unheard of fashion the difficulties of transport of material and precipitated on all the roads enormous quantities of heavy carrying contrivances.

In addition, at the commencement of the Armistice, rearguards blew up the roads, bridges, and railways in all the southwestern portion of the Province to beyond Mons, with large high-explosive bombs, sunk 2 m. in the ground, causing excavations from 8 to 9 m. in diameter by 4 to 6 m. deep. The work of destruction was accomplished for the most part with a minimum of effort and caused a maximum of damage.

In certain parts, notably in the region of Tournai, the German rearguards had obstructed the canals and the navigable waterways, in order to create inundations and paralyze navigation for a long time. All the locks were blown up. On the railways, explosives placed on each rail-joint dislocated the permanent way, and it was only the small non-navigable waterways which were not submitted to this systematic destruction.

All the region south of the Armistice line (Pecq, Ath, Grosage, Mons, Roisin, Chimay) was thus destroyed after the German retreat. They disemboweled the Province by dynamite and dislocated the district as by an earthquake shock, to recover afterward quivering, with its villages shaking or tottering, showing houses in ruins, roads destroyed, excavations of vast craters bordered by crumbling walls, railways devastated, and canals with banks staved in and bridges demolished. The spectacle was that of a region in ruins after a cataclysm. The havoc defied description.

Since the Armistice, English troops have taken pride in clearing the roads constructing provisional works, and rendering serviceable the principal lines of railway.

In January, 1919, the railway from Mons to Quiévrain was repaired, and, section by section, that of Tournai was added to the circulation.

The demobilization has not permitted the English troops to continue to do much. The Public Administrations (Railways, Bridges and Roads, Provinces, and Communes), found labor which was unemployed, and a great amount of work was thus carried out in the neighborhood of Charleroi, and in the Borinage.

For the past six months, the activity has been indeed very great on the essential ways of communication. Legions of workmen have taken in hand the paving works and metaling along the routes from Binche to Bois-Bourdon, from Liége to Mons, from Brussels by Mons to Valenciennes, from Mons to Maubeuge, from Charleroi to Tirlemont, to the main roads of Mons, Tournai, and Charleroi.

The method of work that has prevailed is that called "à bordereau de prix" (literally translated, A/C of price = day work).

One work alone, the putting into a proper state, of the route from Mons to Maubeuge, is being done by American contract (amount 100 000 francs). Work is in course of execution on the route from Binche to Bois-Bourdon (200 000 francs), this is three-quarters finished. The route from Liége to Mons begun at the end of April is now being completed (34 000 francs); that from Mont St. Jean to Bray-les-Binche, begun in March, is finished (30 000 francs). The road from Renaix to Lessines, with new paving and vast repairs, is nearly finished after three months' work (25 000 francs).

The section Brabant-Cateau is divided into portions (172 000, 212 000, and 234 000 francs); the section from Boussu-Quiévrain is similarly divided into three portions, (161 650, 144 000, and 93 000 francs), and the work is completed. The section, Brussels-Lille, five portions, will cost about 1 330 000 francs. The cross-road at Ath (40 000 francs) and the road from Ath to Leuze (86 000 francs), are finished. That of the road from Soignies to Mariemont was undertaken in February, 1919 (40 000 francs).

In April, the work of putting in order the route from Hornu to Barry was begun. It was finished in July (18 000 francs). The route from Ville-Pommeroeul to Roisin (30 600 francs) is in course of completion; also, that from Frameries to Bois-Bourdon (31 000 francs). A section of the route from Mons to Valenciennes (11 000 francs) is half finished. The section from Charleroi-Epinois, of the route from Liége to Mons, by Charleroi and Namur, is finished.

The repairing of the route from Mons toward Rocroy, by Beaumont and Chimay, commenced in March, is finished (18 000 francs).

Besides these works, which are of State domain, there are those which are provincial and municipal, and which are valued at 13 869 825 francs on the basis of 1914 prices; this is understood to include non-navigable waterways.

The cost for urban roads and repairs to water supplies will be 2 500 000 francs and repairs to sewers will entail an expense of more than 500 000 francs.

The works are undertaken by the contractors of the Province, except those which were first taken in hand by the Communes.

Among other works undertaken by the Province may be noted the putting into good order of the system of sewers of Tournai, which

were seriously damaged. This is nearly completed, and repairs are now being effected to the damaged water distributions of Calonne, Bon-Secours, and Dours (300 000 francs).

Belgian Town Planning Information

A big exhibition is being organized at Liége, Belgium, for February, 1920, by the Association des Architectes de Liége, U. P. A. Lg. (Belgium). The Association will exhibit any drawings, models, etc., illustrating engineering, architectural, and other matters in connection with town planning and allied subjects. These should preferably show planning and construction suitable for Belgium. M. A. Snyers, Architecte diplômé, President, Association des Architectes, of 62 rue Louvres, Liége, is President of the Exhibition, while the General Secretary is M. Maurice Legrand, 44 rue Darchés, Liége. A similar exhibition was held at Brussels during September, 1919.

In regard to the Liége Exhibition, it has been decided to display plans showing the proposed reconstruction and remodeling of the city and its environs, models of new bridges to be constructed, and plans and models of various garden cities to be erected on the outskirts.

The Organizing Committee reports that it has the co-operation and assistance of engineers, surveyors, etc., holding official posts, and burgomasters of the adjoining towns. Further, the Committee reports that it has been engaged on the problem of the reconstruction of Visé (where the German Armies entered Belgium), during the past four years, and has had the assistance of MM. Jacquemin, Ingénieur des Ponts et Chaussées, and Vercheval, Ingénieur des Chemins de Fer de l'Etat.

The new railway track constructed by the Germans in the vicinity is to be preserved, also the station at Visé, but many new tracks are to be constructed in the district, the Meuse is to be canalized, and a number of bridges are to be erected.

Reconstruction of France

There is to be a permanent exhibition at Paris, (rue Louis-le-Grand), known as the "Renaissance des Cités". The aim of the promoters is to show what can be done on town-planning lines to restore the damaged towns of France, and to embellish others. Plans of Chauny, photographs of Noyon taken from an aeroplane, and plans for extensions to Paris, are some of the exhibits already placed. There are also documents dealing with the land registry and types of workmen's houses, by Greber, Architect. The text of the Town-Planning Conferences held at the "Société Francaise des Urbanistes", are being published in English.

Housing Problem in England

Sir Charles Tamlin Ruthen, O.B.E., Member of the Council of the Society of Architects, read a paper* before that body on October 16th, 1919, in which he pointed out that even if the brick output is increased 250%, it will be 15 or 20 years before the present shortage can be made good. He proposed wooden houses as a remedy, and stated that they have a life equal to that of the majority of brick houses, and that they were, of course, cheaper. He had effected a saving of about £125 on one he had built. Figures prove that more than a quarter of the population, or more than 7 000 000 persons in England, are improperly housed. He estimated that supposing the housing problem to be satisfactorily dealt with during the next five years, a total of 1 044 000 houses should be built, or considerably more than 200 000 annually. Supposing 25 000 bricks were required per house, it would mean that 5 000 000 000 bricks would be required per annum. In order to obtain this output, all other work would have to cease for the period, or the number of workmen engaged would have to equal 2½ times the number engaged in pre-war days. Even considering this, it is likely that 15 or 20 years will elapse before the actual shortage is remedied.

We have been told that the supply will always meet the demand. In this particular case, the demand is not for houses at any cost, but for houses at or below a certain cost, hence, the absence of supply. If a grave National calamity was to be averted, Sir Charles considered the following to be the five main points in house erection: Rapidity of construction, weather-proof qualities, stability, durability, and cost.

The figures already stated point out the impossibility of erecting brick houses, or slow-built English types of houses. Sir Charles had studied the methods in vogue in America and Canada, for some time, and had noted that many thousands of timber-built houses erected in America have lasted satisfactorily, and have had a life equal to the majority of the brick houses of Great Britain. He, therefore, made a demonstration of rapid-house erection near Swansea, South Wales. The houses are typical examples of American dwelling construction, adapted to English tastes. The foundations are of brick, with a bitumen damp-course, and the framework is of wood. A shield of stucco-board is secured to the framework. This consists of, first, a fibrous board on which a second material—a thick layer of asphalte mastic—is applied, and the third consists of wooden dovetailed lathes embedded under great pressure into the first two. He claims for this construction a thoroughly damp-proof, warm, and vermin-proof building. The external finish is stucco, and the appearance is similar to that of an ordinary brick house with a cement stucco finish. The cost of one of the houses has been £125 less than that of a similar house of 11-in. hollow brickwork. The house was completed in 30 days.

* "A New System of House Building".

Belgian Information

The Belgian Government, sadly in want of means of transport, has decided to acquire 675 locomotives, 375 to be ordered from America, 125 from England, and 175 to be constructed in Belgium. The 125 English locomotives will be those which have been in use on the front during the war. In addition, 9 000 wagons are to be purchased from England.

The industrial region of Charleroi, Belgium, has been visited by Mr. Morgan, the American Commissioner, who has made proposals to the Belgians for credits necessary for the restoration of factories in that region.

Antwerp, which is badly overcrowded, is to embark on a large housing scheme on town-planning lines. Each house will cost 7 250 francs, and will have five rooms and a garret. In addition, there will be an installation of cold-water baths.

"American Independence" Room, Versailles, France

On the afternoon of September 25th, 1919, at the Palace of Versailles, France, a new room was dedicated to American Independence which was proclaimed at Versailles at the end of the campaign in which LaFayette and Rochambeau fought on the side of Washington.

Proposed Registration of Civil Engineers, England

The Council of The Institution of Civil Engineers (England) has decided to introduce a Bill in the next session of the British Parliament, with the object of obtaining statutory powers of registration for Civil Engineers.

The proposal is that, first, the register will contain the names of all Corporate Members of The Institution of Civil Engineers and of The Institution of Civil Engineers of Ireland, and, second, other persons employed as Civil Engineers who are members of important Engineering bodies or who have practiced Civil Engineering for a qualifying period.

A Tribunal is proposed, composed of representatives of the important Engineering Societies, which will determine the eligibility of persons under the second group previously mentioned. By means of this Tribunal, the interests of the members of the various Engineering Societies, who are Civil Engineers, would be safeguarded. There are further proposals dealing with the standard of qualification necessary for future practitioners and for admission to the register, after registration has once been established. The prohibition of unregistered persons assuming the title of Civil Engineer is sought, registered persons only being allowed to use the title.

British Housing Schemes on Town-Planning Lines

Some of these housing schemes are rather ambitious. A few are quoted, as follows: Swansea's (South Wales) scheme of 3 000 houses on the Corporation's estate, which is valued at £2 000 000. The cost of the first installment of houses is £800 each; Ebbw Vale (South Wales), in connection with which sanction has been given for the erection of 3 000 houses, the cost of which will exceed £2 500 000. This scheme involves the rebuilding of the slum areas. Port Glasgow has a £3 000 000 scheme. The City of London Corporation has one £2 000 000 scheme, also a block-dwelling scheme of thirteen blocks. Walthmstow, (North East London), the most important Urban District in England, has a scheme embracing more than 1 500 houses, which will cost with sewers, roads, etc., about £2 000 000. The designs for "lay-outs" on town-planning lines, and for house plans, are being made in the Engineer Department. Edmonton, near London, has a £2 000 000 scheme on town-planning lines, which is being prepared by its Engineer Department.

Healing War Scars

M. Andre Tardieu, at a dinner given by the Franco-American Section of the Cercle Volney, referred to the gigantic task undertaken by France since the armistice was signed, according to the *Sunday Pictorial,* of London, England:

"On September 16th last," he said, "of 1 405 miles of railway track destroyed, 1 260 had been repaired; of 672 miles of canal, 427.

"Of 1 160 constructions, such as bridges and tunnels, which had been blown up, 588 had been replaced; of 550 000 houses ruined by bombardment, 60 000 had been rebuilt, and of some 4 500 000 acres of ground rendered useless by battle, about 988 000 had been recultivated.

"Finally, more than 11 000 000 yards of barbed wire had been removed. These figures prove France's force and vitality."

Developing the Oil Shales of Norfolk

In a recent issue of the *Richmond Herald,* of Surrey, England, it was stated that "while coal is becoming dearer and more difficult to obtain, there is every prospect of our large industrial works being able soon to pass from coal to oil, which, it is proved, can now be produced in England in almost unlimited quantities. The vast oil-shale deposits of Norfolk, spreading over 100 sq. miles, have been estimated to contain more than 2 000 000 000 tons of oil shale, each ton of which has more than 60 gal. of motor spirit and other oil products, and the whole of this area has been acquired and is already being developed by English Oilfields, Limited, under the chairmanship of Sir Robert Heath, the well-known colliery owner. Dr. Forbes Leslie has publicly stated that by treating 70 000 tons of this shale per day it will take more than a century to exhaust the deposits already

located by bore holes, though this quantity is but a fraction of the greater deposits at depth, for, so far, the tests have all stopped at about 300 ft. On the basis of treating 1 000 tons daily, the *Financial Times* estimates that the company's income will be equal to 175% on the capital; the Directors, however, are to erect 18 retorting plants, and each plant will be able to treat 4 000 tons daily. It looks as though the fortunes made out of American oil are to be repeated, but this time nearer home."

Centralizing the Electric Supply

The Electricity Bill, which reached its seventh clause in Committee and there stuck before the adjournment in August, 1919, will again be taken in Committee, as stated recently by the *Evening News*, of London, England.

It is a large and debatable measure and has for its main objective the centralization in huge power stations of the production of electric power for the whole country. It involves the ultimate scrapping of many municipal and small electrical production undertakings, and incidentally the raising of considerable loans.

New Tramways for London, England

A tramway development scheme for London, entails the construction of 90 miles (single line) of tramways. The cost, including street works, totals about £8 000 000. The cost of urgent works recommended is estimated to be about £4 205 000, and the estimated total cost of the proposed widenings necessary for the scheme is nearly £1 000 000.

Edinburgh, Scotland, Turns Down British Tenders Which Are £68 000 More Than Swiss Tenders

The Edinburgh Electric Lighting Committee recommends the acceptance of a tender of a Swiss firm (Brown, Bover and Company), at £106 000, for turbo-alternators for the new power station at Portobello. Of the sixteen tenders received, the three lowest were Swiss, and that recommended is about £68 000 lower than the lowest British tender. The Board of Trade has intimated that it cannot insist on the Corporation accepting a British tender, having regard to such figures.

Two road improvement schemes for London, one a widening of Brentford High Street, and the other an alteration to a route through Croydon, will cost the Road Board alone £900 000.

There is even a shortage of houses in Burma. English folk arriving there find no houses in which to live, for none has been erected for years. We are informed that the only house known to be to let in a Rangoon suburb is held at £300 per annum, and this is quite a small wooden shanty.

Before the war, Belgium had 54 blast furnaces in use, 25 in Hainant Province, 21 in Liége Province, and 8 in Brabant and Luxembourg. Several are already in full activity, while 18 are in a state of progress, and the others only await minerals and coke to be in full use.

The British Ministry of Health has appointed a committee to consider principles to be adopted in the clearance of slum areas, to be known as the "Slum Areas Committee."

A bill has been passed, which will make Town Planning compulsory in England in the near future, for towns of more than 20 000 population.

"The World War" Officially Designated

The Secretary of War has issued an official order declaring that "the war against the Central Powers of Europe, in which the United States has taken part, will hereafter be designated in all official communications and publications as 'The World War' ".

BRIEF NOTES

The National Safety Council announces an affiliation with the University of Cincinnati for the purpose of carrying out a programme that is unique both to the fields of education and accident prevention and that opens a new and promising avenue for the service of the Council. This programme includes the establishment of an Industrial Medicine Division at the University of Cincinnati where medical students and graduate physicians will be given special training not only in industrial medicine, but in industrial relations, including sanitation and all the fundamentals of safety work as well. This school is already under way.

Wilbur M. Wilson has been appointed Associate Professor of Structural Engineering in the Department of Civil Engineering at the University of Illinois.

It is reported that the estimate for canalizing the River Rhône is £100 000 000 (at par exchange). The hydraulic power thus obtained will be equivalent to 5 000 000 tons of coal annually, and extensive tracts of land will be brought under irrigation. The canal section will be large enough to accommodate boats of 1 200 tons. The construction, it is stated, will take about 15 years.

At the end of 1918 the populations of the four largest cities in Japan were: Tokio, 2 331 860; Osaka, 1 633 338; Kyoto, 668 930; Kobe, 591 193.

A press dispatch from Peking, China, states that the Tientsin Government has contracted with Americans for the construction of the Chang Cheng-tu Section of the Sgechua Railway. It is also stated that the necessary financing is being done by Americans.

During the past five years, according to the *Wall Street Journal*, the United States has sold to the rest of the world goods to the value of about $26 500 000 000, of which Europe took about $17 750 000 000 worth.

The cost of living has gone up 102% in the United States, 107% in Canada, 133% in England, and 200% in France since the beginning of the war, according to the results of an investigation just completed by economists of the War Trade Board.

The University of Cincinnati through its College of Engineering and Commerce will give a course in traffic management, which to accommodate those engaged in commercial affairs, will be given in the evening.

Capt. Andre Tardieu, speaking for the Government during the debate in the Chamber of Deputies, at Paris, France, on September 2d, 1919, on the ratification of the German Peace Treaty, said that the French war losses constituted 26% of the men mobilized. Of all the men with the colors under 31 years of age, 57% were killed.

It is announced from London that the salvage of 440 vessels and the recovery of property valued at $250 000 000 is the record in 4 years of the Admiralty Department which has been conducting salvage operations in home and foreign waters.

Recent French dispatches state that the entire road construction programme in France will cost nearly 2 000 000 000 francs, which it is estimated will give France a road system superior to that before the war.

The receipts of the Railway Board of Japan during the fiscal year ending last March, amounted, it is stated, to yen 228 245 000 from traffic, and yen 8 000 000 from other sources, while the total expenditure amounted to yen 2 000 000 000.

G. G. Ward, Vice-President of the Commercial Cable Company, states that a second cable from San Francisco to Japan, by way of Midway Island, is practically assured.

It is announced that the British Association for the Advancement of Science, at its annual meeting, in Bournemouth, England, is planning the development of a scientific history of the world war.

The Journal of Commerce states that at a conference dealing with international co-operation in scientific research, held in Brussels recently, the constitution of an International Research Council was agreed on, and now awaits ratification by appropriate national organizations to come into force on January 1st, 1920.

The *Chicago Tribune* announces that Japan has bought from Germany enough rails and ties to build two trans-Siberian railroads.

The Arizona Resources Board, organized under an Act of the last Legislature, is directed, it is stated, to gather data and to recommend means for the development, conservation, control, and regulation of the water resources, covering the related subjects of irrigation, drainage, flood control, utilization of water power, water development for agricultural, mining, stock raising, industrial, municipal and domestic purposes, with due regard to the rights of the State and the people.

It is announced that the Belgian Government has ordered 400 American locomotives for use on State railroads.

The *Wall Street Journal* quotes the *Manchester Guardian* as saying that Herbert Hoover, M. Am. Soc. C. E., has been the nearest approach to a dictator that Europe has had since Napoleon, and states that Mr. Hoover was in supreme economic command when economics were more important than politics, and that Eastern Europe looks to him as a new prophet.

It is announced that C. M. Schwab, President of the Bethlehem Steel Corporation, intimates that the railroads of the United States will need, approximately, 5 000 000 tons of steel rails during the next 12 months.

On September 17th, 1919, the U. S. Geological Survey issued the latest report on the ground-waters of Southern California, prepared by G. A. Waring, and covering the San Jacinto and Temecula Basins. It contains a general description of the geology and water resources of the region and a detailed description of the ground-waters in each of eleven districts into which the region is divided.

According to a statement made by Peter C. Hewitt, of New York City, talks with Europe by wireless telephone will be an ordinary event for American business men within three years.

The American Contractor states that the release of structural steel from war requirements, the high rents obtainable for all kinds of structures, and the greater demand for housing are resulting in an increasing number of plans filed with various cities for new construction. Building permits issued in 153 cities of the United States during August, 1919, exceed by 267%, the figures for August, 1918.

A. P. Davis, M. Am. Soc. C. E., Director of the Reclamation Service, on September 18th, 1919, told the Senate Committee on Irrigation that $112 000 000 would be needed to complete the reclamation projects under way at present.

It is announced from London that the Finance Committee of the Cabinet has decided to suspend at once all work on naval construction, except warships approaching completion or about to be launched. The workmen will be transferred to shipyards constructing merchant vessels, the expected result being an increase in output.

The *Wall Street Journal* quotes a cable to the effect that the French plan a society for the erection of 10 large hotels on the sites of famous battles for the accommodation of tourists expected next spring. The Government has been asked to grant a subsidy of $6 000 000 for the project.

In the opinion of Stephen C. Mason, President of the National Association of Manufacturers, strikes have cost the United States $10 000 000 a day in the last 8 months.

The Director of the Census announces that final plans for the Fourteenth Decennial Census are practically complete. Nearly 90 000 persons will collect and tabulate the statistics concerning the population of the United States; of these, 85 000 will work in the field, while the remainder will comprise the Washington office force.

In the opinion of Mr. Allen Beals, in an address before the New York and New England Brick Manufacturers, the United States needs 1 300 000 homes, 450 000 factories, 5 000 schools and institutions, 55 000 apartment houses, 20 000 theatres and churches, 120 freight terminals, and 14 000 railroad stations and freight sheds.

A cable to the *New York Sun* states that S. C. Davidson, of the Sirocco Engineering Works, England, has invented an apparatus to cheapen and expedite the manufacture of rubber, by converting latex into rubber within 24 hours, instead of 2 weeks, as at present. It is estimated that this process, if practicable on a large scale, will revolutionize the rubber industry.

It is announced from Portsalon, Ireland, that a British salvage ship is attempting to raise $35 000 000 in gold ingots and bullion carried by the White Star liner *Laurentic* when it was sunk in 1917. A day's record haul so far has been $350 000.

It is reported by the Statistics Branch, of the General Staff, that the Spanish Minister of Public Works desires to purchase large quantities of dredges, pile-drivers, and other equipment and machinery for harbor improvement and canal building. Material of this character in Europe, owned by United States, has been sold to the French Government, but other equipment, not shipped overseas, will be available for sale to Spain.

The *Chicago Tribune* states that a Japanese inventor has patented a device for using balloons to raise sunken vessels.

It is reported, in *Woman's Century,* for September, 1919, that Orson, Sweden, is a municipality without taxes. The local railway is free to every citizen, no charge is made for telephone service, schools, and libraries. A large area of land had been acquired for the city many years ago, and planted with trees, with the result that, during the past 30 years, the town authorities have sold more than $5 000 000 worth of trees and timber, while replantings have provided a similar income for the future.

It is announced from Cöpenhagen that the Director of State Railways of Denmark has prepared plans for building railway bridges connecting Zealand with the Isle of Falster and Fyn with Jutland, making communication with Germany easier.

The French Industrial Association has created a committee, it is reported, for the return to technical studies, the purpose being to assist engineering candidates, whose studies have been interrupted by the war, to enter industrial careers.

Paris announces that Poland will send to France 100 000 workers, including cultivators, miners, and masons, who will be employed in rebuilding the devastated district.

The *Wall Street Journal* reports that air raids cost London more than $75 000 000.

The *Journal of Commerce* states that the Japanese Home Office has arranged to furnish the cities of Tokyo, Osaka, Kyoto, Yokohama, Kobe, and Nagoya with capital at a low rate of interest to construct dwellings. The authorities in Osaka plan to build 10 000 tenements to be under municipal management and to cost $10 000 000.

The National Budget Committee has made public the final results of a canvass of State Governors, initiated to determine their stand upon the question of National budgetary reform. Forty of the forty-eight State Executives have given their unqualified endorsement to the Committee's plan to secure the adoption of a budget system by Congress.

Ground was broken on November 6th, 1919, for the first of a group of buildings to house the Engineering School of New York University, on University Heights, New York City. It is estimated that the buildings will cost nearly $800 000.

John F. Stevens, M. Am. Soc. C. E., head of the American Railway Commission to Russia, was recently decorated with the Distinguished Service Medal by Maj.-Gen. William S. Graves, U. S. A., commanding the American forces in Siberia.

Statistics of foreign imports and exports for the year ending August 31st, 1919, issued by the Department of Commerce, show that the year's commerce exceeded that of 1918 by more than $1 500 000 000, while the balance of trade in favor of the United States was more than $1 000 000 000 larger.

It is announced in the *Chicago Tribune* that information from American investigators concerning industrial conditions in Germany indicates belief that Germany will recuperate faster than any other European nation.

J. S. Williams, Comptroller of Currency, in an address before the National Bank Section of the American Bankers' Association, at St. Louis, Mo., outlined the enormous task laid on American banking of rehabilitating the world. He stated that on June 30th, 1914, the total resources of all the National banks were $11 482 000 000. On June 30th, 1919, the resources were $20 799 000 000, an increase of $9 317 000 000.

The *San Francisco Chronicle* reports that statistics show that there are 6 000 000 automobiles in use in the United States to-day. This indicates that an average mileage of 3 000, which is quite low, equals 18 000 000 000 miles a year.

The first American Trade Commissioner to Poland will be Louis E. Van Norman, whose assignment to Warsaw is announced by the Bureau of Foreign and Domestic Commerce, Department of Commerce. Mr. Van Norman, who has just completed a survey of the situation in Roumania, is the author of "Poland, the Knight Among Nations," and numbers among his personal friends some of the best-known Polish leaders. During the war he was identified with the War Trade Board at Washington.

It is announced from Honolulu by Governor C. J. McCarthy that the United States Government, co-operating with the Territory, proposes to expend $15 000 000, over a period of from 6 to 8 years, for new roads and road improvements and extensions on the Island of Oahu.

A leading investment banker of Chicago, Ill., states that America has 20 000 new millionaires as the result of prosperity superinduced by the war.

It is announced that building permits with an estimated valuation of $137 023 736, were issued in 160 cities in the United States during September, 1919, compared with $160 947 233 in 153 cities in August, 1919, which was the "boom" month in building activity during the current year. J. P. H. Perry, M. Am. Soc. C. E., Vice-President of the Turner Construction Company, of New York, states that the steady mounting costs of building material, shortage of labor, and

social unrest, will inevitably cause a 15% increase in the cost of the construction of building projects next spring.

The Bureau of Markets issues a publication entitled, "Notes on Grain Pressures in Storage Bins". The purpose of the report is to facilitate the design of grain bins by engineers, and the contents include tables of pressures, graphical charts, and rules for the more advantageous application of pressure tables.

The Bureau of Public Roads announces that although expenditures during 1919 for hard-surface highways, according to its estimates, will set a new record with a total of $138 000 000, this figure is small in comparison with the computed available total for 1920 of $633 000 000, the spending of which promises to be dependent chiefly on the quantity of materials which the present limited railway facilities can transport.

The U. S. Geological Survey has issued *Water Supply Paper No. 485*, entitled "Surface Water-Supply of Hawaii, July 1, 1917, to June 30, 1918," which states that the annual exports from Hawaii now amount to more than $80 000 000, nearly all of which represents agricultural products sent to the United States. Most of these products are raised by irrigation.

The *New York Sun* reports that the building needs of the United States include 1 000 000 homes, 128 000 factories, costing $100 000, or more; 325 000 factories costing less than $100 000 each; 6 000 hotels, 5 000 schools and public institutions, 50 000 apartments, 120 major freight terminals, 14 000 railroad stations and freight sheds, and 20 000 churches and theatres.

ANNOUNCEMENTS

The Reading Room of the Society is open from 9 A. M. to 10 P. M., every day, except Sundays, New Year's Day, Fourth of July, Labor Day, Thanksgiving Day, and Christmas Day; during July and August, it is closed at 6 P. M.

FUTURE MEETINGS

January 7th, 1920.—A regular business meeting of the Society will be held, the programme for which will be announced later.

ANNUAL MEETING

The Sixty-seventh Annual Meeting will be held at the Headquarters of the Society, 33 West 39th Street, New York City, on Wednesday and Thursday, January 21st and 22d, 1920.

COMMITTEE OF ARRANGEMENTS

LEWIS D. RIGHTS, *Chairman,*

CHARLES GILMAN
GEORGE L. LUCAS
FRANCIS MASON
CHAS. WARREN HUNT

The Business Meeting will be called to order at 10 o'clock on Wednesday morning. The Annual Reports will be presented, Officers for the ensuing year elected, members of the Nominating Committee appointed, Reports of Committees presented for discussion, and other business transacted.

LIST OF NOMINEES FOR THE OFFICES TO BE FILLED AT THE ANNUAL ELECTION, JANUARY 21st, 1920

The following list of nominees for the offices to be filled at the Annual Meeting, January 21st, 1920, received from the Nominating Committee, was presented to the Board of Direction at its meeting on October 14th, 1919. The list has been mailed to all Corporate Members:

For President, to serve one year:

ARTHUR POWELL DAVIS, Washington, D. C.

For Vice-Presidents, to serve two years:

ROBERT AUGUSTUS CUMMINGS, Pittsburgh, Pa.
FRANCIS LEE STUART, New York City

For Treasurer, to serve one year:

ARTHUR SMITH TUTTLE, New York City

For Directors, to serve three years:

CLARENCE WALTER HUDSON, New York City.....District No. 1
CARLETON GREENE, New York City.....District No. 1
JOHN ADAM O'CONNOR, Albany, N. Y.....District No. 3
JOHN CLAYTON HOYT, Washington, D. C.....District No. 5
ANSON MARSTON, Ames, Iowa.....District No. 7
DAVID CHRISTIAAN HENNY, Portland, Ore.....District No. 12

NATIONAL SERVICE COMMITTEE OF ENGINEERING COUNCIL

In response to frequent expressions of need, Engineering Council announces the establishment of a National Legislative and Departmental Information Service for engineers in all branches of the Profession. Information relative to engineering statistics, research, and construction, as well as of matters before Congress involving engineering considerations, will be furnished without charge by addressing the National Service Committee, M. O. Leighton, Chairman, 502 McLachlen Building, Washington, D. C. The National Service Committee also announces that its office at Washington is open to members of the Society at all times, and that accommodations can be had there at short notice for committee meetings of the Society, or of any organization in which the Society is interested, which may be held in Washington.

HOW TO MAKE REMITTANCES TO THE SOCIETY

The attention of members is called to the rule (see Year Book, 1919, page 20), that all remittances should be made payable to the order of the American Society of Civil Engineers. Checks, drafts, money orders, etc., should never be drawn to the order of an individual in payment of a bill from the Society. Observance of the rule will expedite clerical work and prevent avoidable delay in the closure of accounts.

ROLL OF HONOR

Now that the war is over, the monthly publication in *Proceedings* of the Roll of Honor has been discontinued. It is planned to publish later for permanent record a list of all the members of the American Society of Civil Engineers whose names have appeared on this list.

ENGINEERING SOCIETIES EMPLOYMENT BUREAU

Engineering Societies Employment Bureau, established December 1st, 1918, as an activity of Engineering Council, is managed by a board made up of the Secretaries of the four Founder Societies, funds for its maintenance being provided by these Societies. The work of the Bureau since its inception has been largely in the line of securing employment for men retiring from government war service. Members of the American Society of Civil Engineers who desire to register with this Bureau should apply for further information, registration forms, etc., to Walter

V. Brown, Manager, Engineering Societies Employment Bureau, 16th Floor, Engineering Societies Building, 29 West 39th Street, New York City.

SEARCHES IN THE LIBRARY

As the Library of the American Society of Civil Engineers has been merged in the Engineering Societies Library, requests for searches, copies, translations, etc., should be addressed to the Director, Engineering Societies Library, 29 West 39th Street, New York City, who will gladly give information concerning the charges for the various kinds of service. A more comprehensive statement in regard to this matter will be found on page 21 of the Year Book for 1919.

PAPERS AND DISCUSSIONS

Members and others who take part in the oral discussions of the papers presented are urged to revise their remarks promptly. Written communications from those who cannot attend the meetings should be sent in at the earliest possible date after the issue of a paper in *Proceedings*.

All papers accepted by the Publication Committee are classified by the Committee with respect to their availability for discussion at meetings.

Papers which, from their general nature, appear to be of a character suitable for oral discussion will be published as heretofore in *Proceedings*, and set down for presentation to a future meeting of the Society, and, on these, oral discussion, as well as written communications, will be solicited.

All papers which do not come under this heading, that is to say, those which from their mathematical or technical nature, in the opinion of the Committee, are not adapted to oral discussion, will not be scheduled for presentation to any meeting. Such papers will be published in *Proceedings* in the same manner as those which are to be presented at meetings, but written discussions only will be requested for subsequent publication in *Proceedings* and with the paper in the volumes of *Transactions*.

The Board of Direction has adopted rules for the preparation and presentation of papers, which will be found on page 35 of the Year Book for 1919.

LOCAL ASSOCIATIONS OF MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

San Francisco Association, Organized 1905.

E. J. Schneider, President; Nathan A. Bowers, Secretary-Treasurer, 502 Rialto Building, San Francisco, Cal.

The San Francisco Association of Members of the American Society of Civil Engineers holds regular bi-monthly meetings, with banquet,

and weekly informal luncheons. The former are held at 6 P. M., at the Engineers' Club, 57 Post Street, on the third Tuesday of February, April, June, August, October, and December, the last being the Annual Meeting of the Association.

Informal luncheons are held at noon, every Wednesday, at the Engineers' Club, where special tables are reserved for members and guests of the Association.

The by-laws of the Association provide for the extension of hospitality to any member of the Society whom may be temporarily in San Francisco, and any such member will be gladly welcomed as a guest.

(Abstract of Minutes of Meeting)

August 19th, 1919.—The meeting was called to order at the Engineers' Club; President E. J. Schneider in the chair; Nathan A. Bowers, Secretary; and present, also, 58 members and guests.

The Secretary read a letter from Lt.-Commander Carlson, expressing appreciation of the good wishes of the Association sent him in connection with thanks for his work in facilitating the Mare Island trip.

The Secretary also read a letter from Mrs. Schussler, expressing appreciation for the letter of sympathy sent to her by the Association on the death of the late H. F. A. Schussler, M. Am. Soc. C. E.

Mr. H. L. Haehl, as representative of the Association, made a brief report on the June meeting of the Committee on Development of the Society, asking for suggestions or criticisms from the members.

Mr. H. J. Brunnier, for the Membership Committee, outlined briefly the methods used by other societies in membership campaigns.

Mr. F. R. Muhs, for the Entertainment Committee, asked for suggestions as to future inspection trips for the Association, and trips to the San Pablo Dam and the Marin Municipal Water District were proposed and discussed.

Secretary Bowers presented a progress report relative to the organization of a California Council of Engineers, and requested the opinion of the Association about replying to the invitation from the San Francisco Joint Council to approve and appoint delegates to the State Council. After a brief discussion of the subject, on motion, duly seconded, it was decided to approve the State Council plan and to instruct the Chair to appoint delegates. President Schneider later appointed Messrs. C. E. Grunsky and E. T. Thurston as delegates.

Mr. C. E. Grunsky reviewed the plan for the organization of a National Department of Public Works. President Schneider called for discussion in opposition to the plan, and, as there was no opposition or discussion, on motion, duly seconded, it was adopted unanimously. It was also suggested that the fact that no opposition to the plan in written form had been received by the Association after the *pro* and *con* statement relative to it had been printed in the Association's *Proceedings*, be put on record.

Mr. Grunsky outlined the proposed voluntary subscription plan for financing the campaign for the National Department of Public Works, and, on motion, duly seconded, the Board of Directors was authorized to send solicitations to all members of the Society in San Francisco.

The plan to endorse Mr. W. W. Atwater as State Water Commissioner to succeed Mr. A. E. Chandler, was discussed, and, on motion, duly seconded, the Board of Directors was instructed to direct the attention of the Governor to the desirability of appointing an engineer to the position of Water Commissioner and that the qualifications of Mr. Atwater for this position be mentioned.

Relative to the vacancy on the San Francisco Board of Public Works, it was decided, on motion, duly seconded, that the Public Relations Committee of the Association be instructed to co-operate, if possible, with the Joint Council of Engineering Societies of San Francisco in this matter.

President Schneider reported that the Association had been invited to appoint a committee to co-operate with the State Civil Service Commission in the matter of wages of engineering employees, and that he had appointed the following as members of such Committee; Jerome C. Newman, Chairman; E. B. Bumsted, A. J. Cleary, J. D. Galloway, and F. T. Oakley.

In response to an invitation from President Schneider, the Secretary presented a discussion on the need of co-operation among engineers, urging "co-ordination of effort with every other body of progressive technical men to the end that an improvement of conditions may result."

A cordial welcome was extended by President Schneider, on behalf of the Association, to Capt. E. T. Thurston, who spoke briefly of his work with the American Expeditionary Forces in France.

On motion, duly seconded, it was decided unanimously that the Board of Directors be instructed to address to Mr. A. E. Chandler, the outgoing Chairman of the State Water Commission, the appreciation of the Association for service to the State rendered in an able manner.

President Schneider introduced Mr. Frank G. White, Chief Engineer of the State Board of Harbor Commissioners, who addressed the meeting on "The Improvement of the Harbor Facilities of San Francisco", illustrating his remarks with lantern slides, and the subject was discussed briefly by Messrs. Newman and Saph.

On motion, duly seconded, a vote of thanks was extended to Mr. White for his excellent paper.

Adjourned.

Colorado Association, Organized 1908.

W. C. Huntington, President; A. N. Miller, Secretary-Treasurer, 1400 West Colfax Avenue, Denver, Colo.

The meetings of the Colorado Association of Members of the American Society of Civil Engineers (Denver, Colo.) are held on the second Saturday of each month, except July and August. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary. The meetings are usually preceded by an informal dinner. Members of the American Society of Civil Engineers will be welcomed at these meetings.

Weekly luncheons are held on Wednesday, at 12.30 P. M., at Daniels and Fisher's

Visiting members are urged to attend the meetings and luncheons.

(Abstract of Minutes of Meetings)

September 13th, 1919.—The meeting was called to order at the Shirley Hotel; President W. C. Huntington in the chair; A. N. Miller, Secretary; and present, also, 8 members and 5 guests.

The minutes of the meeting of June 14th, 1919, were read and approved.

On motion, duly seconded, it was ordered that the Executive Committee draw up resolutions on the death of Thomas W. Jaycox, spread the resolutions on the minutes, and send a copy to his family.

The Secretary read a letter from the State Railroad Commission of Colorado, requesting the co-operation of the members of the Association in securing, for the Commission, engineering data and information on the cost, etc., of the construction of two low-grade tunnels through the Continental Divide, at an elevation of approximately 9 100 ft. above sea level. One tunnel is to be built on the Moffat Road, west of Denver, to connect the drainage basin of the Platte with that of the Grand River, and the other on the Denver and Rio Grande Railroad, northwest of Salida, to connect the drainage basin of the Arkansas with that of the Gunnison River.

On motion, duly seconded, it was ordered that the Secretary acknowledge the receipt of the communication, and that President Huntington appoint a committee to look into the matter and draw up resolutions to be presented at the next meeting, and that the Commission be advised of the action taken.

Professor Milo Ketchum addressed the meeting briefly on his work in connection with his new position as Professor of Civil Engineering at the University of Pennsylvania.

On motion, duly seconded, it was ordered that the regrets of the Association be extended to Professor Ketchum on the loss of so valuable a member.

Mr. M. C. Hinderlider addressed the meeting on "Drainage and Sealage of Porous Foundations and Abutments of High Dams by Means of Cement Under High Pressure."

Adjourned.

October 11th, 1919.—The meeting was called to order at the Shirley Hotel; President W. C. Huntington in the chair; A. N. Miller, Secretary; and present, also, 12 members and 3 guests.

The minutes of the meeting of September 13th, 1919, were read and approved.

The Secretary read a letter of sympathy addressed to Mrs. Jaycox by the Executive Committee, on behalf of the Association, in accordance with the resolutions adopted at the meeting of September 13th, on the death of Thomas W. Jaycox.

L. R. Hinman, Chairman of the Committee co-operating with the State Railroad Commision of Colorado in the matter of tunneling the Continental Divide, reported progress.

The Secretary read a communication embodying resolutions from the American Institute of Mining and Metallurgical Engineers condemning the Engineers' License Bill passed at the last session of

the State Legislature and requesting action by the National Engineering Societies with a view to securing its repeal.

On motion, duly seconded, the following resolution was adopted:

"That it is the sense of this meeting that we are not in favor of the repeal of the Engineers' License Bill."

On motion, duly seconded, it was further resolved:

"That we advise the members of the American Institute of Mining and Metallurgical Engineers and the Governor of Colorado of our action, as above mentioned, and that we further advise the members of the Mining and Metallurgical Engineers that we are willing to cooperate with them and with other National Engineering Organizations in an endeavor to improve by amendment the present license law."

Maj. Ivan C. Crawford addressed the meeting on "Pioneer Engineer Regiments in France."

Capt. John S. Means also addressed the meeting, on his work in France, particularly as to methods of sanitation and sewage disposal, and President Huntington spoke briefly on the functioning of the Students Army Training Corps during the war period.

Adjourned.

Atlanta Association, Organized 1912.

T. P. Branch, President; J. T. Wardlaw, Secretary-Treasurer, 1530 Healey Bldg., Atlanta, Ga.

Informal luncheons are held for members of the Association on the last Monday of each month, at 12.30 P. M. The place is not fixed, but this information will be furnished on application to the Secretary.

Baltimore Association, Organized 1914.

H. G. Perring, President; Charles J. Tilden, Secretary-Treasurer, The Johns Hopkins University, Baltimore, Md.

Cleveland Association, Organized 1914.

F. D. Richards, President; George H. Tinker, Secretary-Treasurer, 516 Columbia Building, Cleveland, Ohio.

The regular meetings of the Association are held on the second Wednesday of each month at 12.15 P. M., in the Rooms of the Electrical League, on the Fourteenth Floor of the Statler Hotel. Luncheon is served at these meetings, and visiting members are invited to attend.

(Abstract of Minutes of Meeting)

November 12th, 1919.—The meeting was called to order at the Electrical League Rooms, at 12.15 P. M.; President F. D. Richards in the chair; George H. Tinker, Secretary; and present, also, 18 members.

On motion, duly seconded, the reading of the minutes of the previous meeting was omitted.

The Secretary reported on the State Convention of Engineers and Architects, held at Columbus, Ohio, on October 14th and 15th, 1919, and presented the revised Constitution of the Association of Ohio Technical Societies.

On motion, duly seconded, the Constitution was approved and a copy of the report of the Convention was ordered to be purchased for each member of the Association.

The Secretary read a letter from Director Harry Hawgood relative to the place for holding the Annual Convention of the Society in 1920, and, on motion, duly seconded, a letter-ballot on the choice of place was ordered.

The resolution of the Pittsburgh Association in reference to the action of Engineering Council's Committee on Compensation was read, and, on motion, duly seconded, was endorsed by the meeting.

On motion, duly seconded, the President was instructed to appoint a committee to draft a letter to the family of Mr. A. J. Himes, and President Richards subsequently appointed Messrs. Beahan and Clark as such committee.

Adjourned.

Connecticut Association, Organized 1919.

C. M. Saville, President; R. J. Ross, Secretary, Municipal Building, Hartford, Conn.

The Annual Meeting of the Association is held in April. The time and place of other meetings are not fixed, but this information will be furnished on application to the Secretary.

Detroit Association, Organized 1916.

T. A. Leisen, President; Clarence W. Hubbell, Secretary, 2348 Penobscot Building, Detroit, Mich.

The regular meetings of the Association are held on the second Friday of December, April, and October, the last being the Annual Meeting.

District of Columbia Association, Organized 1916.

A. P. Davis, President; John C. Hoyt, Secretary-Treasurer, U. S. Geological Survey, Washington, D. C.

(Abstract of Minutes of Meeting)

September 12th, 1919.—The meeting was called to order at the Cosmos Club, at 8.30 P. M.; President A. P. Davis in the chair; John C. Hoyt, Secretary; and present, also, 30 members and guests.

The meeting was called for the purpose of discussing the report of the Committee on Development presented to the Annual Convention of the Society on June 17th, 1919, and all members of the Society residing in Maryland, Virginia, and the District of Columbia, were invited to attend.

The report was reviewed and discussed by Mr. G. R. Putnam, the local representative on the Committee, and by Mr. Richard L. Humphrey, representing the Philadelphia Association, who is also a member of the Joint Conference and the Committee on Procedure.

The report was discussed further by Col. Koutz and by Messrs. Averill, Conway, Copeland, and Hoyt.

Adjourned.

Duluth Association, Organized 1917.

G. A. Taylor, President; Walter G. Zimmermann, Secretary, Wolvin Building, Duluth, Minn.

The regular meetings of the Association are held at noon on the third Monday of each month (usually at the Kitchi Gammi Club), with luncheon, followed by a short business session and the reading of papers. Visiting members of the American Society of Civil Engineers can secure from the Secretary definite information relative to the meetings, at which they will be welcomed. The Annual Meeting is held on the third Monday in May.

(Abstract of Minutes of Meetings)

September 15th, 1919.—The meeting was called to order at the Kitchi Gammi Club; President G. A. Taylor in the chair; Walter G. Zimmermann, Secretary; and present, also, 19 members and 3 guests.

President Taylor introduced to those present two new members of the Association, Col. F. R. Pope and Mr. John I. Quinn.

The minutes of the meetings of July 21st and August 18th, 1919, were read and approved.

The Secretary read communications as follows: From Mr. E. R. Lewis, on "Engineering Organization and Unity"; from W. N. Jones, Secretary of the Northwestern Association, and also from the Secretary of the San Francisco Association, enclosing printed reports by members of those Associations in regard to the four main points under discussion by the Development Committee of the Society, which reports, on motion, duly seconded, were referred to Mr. W. N. Hoyt, the representative on that Committee; and correspondence between Messrs. Hoyt, Chas. Warren Hunt, and the American Concrete Pipe Association, pertaining to the study of the concrete culvert pipe problem.

Mr. Hoyt announced that the next meeting of the Committee on Development would be held at Detroit, Mich., on September 22d, 1919, and that, as suggested at the July meeting of the Association, he would appreciate a call for a special meeting before that date, in order to discuss briefly the report of the Development Committee, as submitted to the Society at the Annual Convention on June 17th, 1919.

On motion, duly seconded, it was decided to call such special meeting of the Association for September 19th, 1919, and invitations were ordered to be sent to members of the other National Societies resident in Duluth to be present and take part in the discussion.

Mr. Lyonel Ayres reported for the Entertainment Committee that he had received an invitation for the members of the Association to inspect a new dam being constructed by the Great Northern Power Company at Boulder Lake. On motion, duly seconded, the Entertainment Committee was requested to arrange for this trip by automobile, the date to be decided by the Committee.

Adjourned.

September 19th, 1919.—A special meeting of the Association was called to order at the Kitchi Gammi Club; Second Vice-President J. L. Pickles in the chair; W. H. Woodbury, acting as Secretary; and present, also, 12 members.

The discussion of the report of the Development Committee of the Society, as submitted to the Annual Convention, was opened by Mr. W. N. Hoyt, the representative on the Committee from this Association, following which each of the main topics of the report was discussed in turn. The discussion brought out the fact that local feeling is very favorable to the report of the Development Committee.

The Entertainment Committee reported as to the details of the arrangements for the trip to Boulder Lake.

Adjourned.

On September 29th, 1919, at the invitation of the Great Northern Power Company, a party of 13 members and 3 guests left Duluth in three automobiles, furnished by members of the Association, and went to Boulder Lake, where the Company is constructing a new concrete dam to return water for power development.

The dam will provide a storage capacity in the reservoir of 39 sq. mile-ft., with a tributary drainage area of 60 sq. miles. The flooded area is estimated at 7.08 sq. miles, with a maximum depth of 20 ft. The dam will be 348 ft. 7 in. long and 20 ft. high, and consists of six concrete arches with concrete counter walls, all resting on rock. It was designed by Gardner S. Williams, M. Am. Soc. C. E.

The members of the Association who accepted the Company's invitation enjoyed the trip which was made instructive by W. N. Ryerson, Manager of the Company, who explained the details of the work.

Illinois Association, Organized 1916.

H. J. Burt, President; Edgar S. Nethercut, Secretary-Treasurer, 1735 Monadnock Blk., Chicago, Ill.

The regular meetings of the Association are held on the second Monday of March, June, September, and December, the last being the Annual Meeting. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary.

Louisiana Association, Organized 1914.

Arsène Perrilliat, President; Eugene F. Delery, Secretary, 503 City Hall Annex, New Orleans, La.

The regular meetings of the Association are held at The Cabildo, New Orleans, La., on the first Monday of January, April, July, and October.

Nebraska Association, Organized 1917.

*John A. Bruce, Acting President; Homer V. Knouse, Secretary-Treasurer, 200 City Hall, Omaha, Nebr.

Regular meetings of the Association are held on the first Saturday of each month, except July and August, and at such places as may be appointed from time to time by the Executive Committee. The Annual Meeting is held in Lincoln, Nebr., on the second Friday in January.

Visiting members of the Society are especially urged to communicate with the Secretary when in the city.

* Mr. Adna Dobson, the President of the Association, died on May 4th, 1919.

Northwestern Association, Organized 1914.

Ralph D. Thomas, President; W. N. Jones, Secretary, City Engineer's Office, City Hall, Minneapolis, Minn.

The meetings of the Association are held bi-monthly, alternating between St. Paul and Minneapolis, on the third Friday of each month. Information as to the time and place of such meetings will be furnished on application to the Secretary.

Philadelphia Association, Organized 1913.

S. M. Swaab, President; Henry T. Shelley, Secretary, 416 City Hall, Philadelphia, Pa.

The regular meetings of the Association are held at the Engineers' Club of Philadelphia, 1317 Spruce Street, on the first Monday in January, April, and October, the last being the Annual Meeting. Special meetings will also be held during the winter, in order to provide an opportunity for members to take a more active part in the work of the Association.

(Abstract of Minutes of Meetings)

September 5th, 1919.—The special meeting was called to order at the Engineers' Club; Past-President Samuel T. Wagner in the chair; H. T. Shelley, Secretary; and present, also, 21 members.

The meeting was called to discuss and pass upon finally the report of the Committee on Development of the Society, submitted to the Board of Direction in June, 1919. This report had been discussed at a special meeting of the Association held in August, 1919, and, on motion, duly seconded, had been referred to the Development Committee of the Association for review, with a request that that Committee present its criticisms of the report at this meeting.

Mr. Benjamin Franklin, Chairman of the Association's Committee on Development, reported that the Committee had found that its recommendations coincided very closely with those of the Society's Committee, and that, with a few exceptions, he recommended the report be accepted by the Association.

After a spirited discussion, it was voted unanimously that the Association go on record as heartily endorsing the report of the Committee on Development of the Society. It was also voted to submit for the consideration of that Committee the following suggestions:

That in Section D, Relation to Public Affairs, Paragraph 1, the definition of Engineering should be brief and concise.

That the Code of Ethics should include fees and salaries.

That a standard bill for the Licensing of Engineers should be prepared in co-operation with other National Societies.

That the recommendation of the Committee be extended to include publications tending to bring the activities of the Society under the fullest observation of the reading public and that the individual effort of the members be directed at all times to that end.

That it be the duty of the Local Associations to form Welfare Committees, the personnel of which should have membership in such civic organizations as Chambers of Commerce, Boards of Trade, etc., and that the activities of these Committees be co-ordinated with similar committees of other Societies.

On motion, duly seconded, it was decided unanimously that the Secretary be requested to forward to Mr. Onward Bates, Chairman, a statement of the action taken by the Association on the report of his Committee on Development.

Past-President Wagner called the attention of the members of the Association to the request for individual opinions on the report.

On motion, duly seconded, it was decided that the Association accept the invitation of the Franklin Institute to join in making the December meeting of the Institute a joint meeting. This meeting is to be held on Wednesday, December 17th, 1919, and a paper by Brig.-Gen. R. C. Marshall, M. Am. Soc. C. E., Chief of the Construction Division of the United States Army, entitled "The Work of the Construction Division of the United States Army During the World War", will be presented by the author.

Adjourned.

October 6th, 1919.—The Annual Meeting was called to order at 8.15 P. M., at the Engineers' Club; Vice-President Harrison Souder in the chair; H. T. Shelley, Secretary; and present, also, 80 members.

On motion, duly seconded, the minutes of the meeting of April 7th, 1919, were approved without reading.

Messrs. Carroll R. Thompson and Ralph J. Lawrence were appointed Tellers to canvass the vote for Officers and Directors for 1920.

Messrs. Charles H. Stevens and Samuel I. Sacks were appointed a committee to audit the accounts of the Secretary and Treasurer submitted to the Board of Directors.

Mr. Richard L. Humphrey presented to the meeting some of the most important features of the Report of the Committee on Development to the Board of Direction of the Society.

Vice-President Souder announced that the subject for discussion at the meeting was "The Best Method of Securing Increased Compensation for the Engineer". The discussion was opened by Mr. Humphrey, who was followed by Mr. C. B. Voynow. Papers on the subject were also submitted by Messrs. E. G. Perrot, R. G. Develin, Wager Fisher, and Benjamin Franklin.

A general discussion of the subject followed in which many of those present at the meeting took part.

The report of the Tellers was presented, and Vice-President Souder announced the election of the following officers: President, S. M. Swaab; Vice-President, Jonathan Jones; Treasurer, R. G. Develin; and Directors, Messrs. Benjamin Franklin and Wager Fisher.

The President-elect, Mr. Swaab, then took the chair and addressed the meeting.

On motion, duly seconded, the next meeting of the Association was fixed for November, the date to be announced later by the Secretary.

Adjourned.

Pittsburgh Association, Organized 1917.

Morris Knowles, President; Nathan Schein, Secretary-Treasurer, 426 City-County Building, Pittsburgh, Pa.

The Annual Meeting of the Association is held on the first Monday in October. The time and place of other meetings are not fixed, but this information will be furnished on application to the Secretary.

(Abstracts of Minutes of Meeting)

October 6th, 1919.—The Annual Meeting was called to order at the Hotel Chatham; President R. A. Cummings in the chair; Nathan Schein, Secretary; and present, also, 35 members and guests.

The minutes of the previous meeting were read and approved.

Mr. W. A. Weldin reported on the work of the Activity Committee, giving an account of the excursion and inspection trip to the new By-Product Plant of the Carnegie Steel Company, at Clairton, Pa., at which about 60 members and guests were present.

A progress report from the Sub-Committee on Internal Affairs of the Association, was presented.

President Cummings addressed the meeting informally on the work of the Committee on Development of the Society.

The President announced that a committee consisting of Messrs. Judd, Weldin, Taylor, Layton, Hopkins, and Demorest, had represented the Association at the dedication of the Bureau of Mines.

The following nominations for officers of the Association for the ensuing year, were reported by the Nomination Committee: President, Morris Knowles; Vice-President, N. S. Sprague; and Secretary-Treasurer, Nathan Schein.

On motion duly seconded, the nominations were closed, and the Secretary was ordered to cast a ballot for the names submitted by the Nominating Committee.

President Knowles then assumed the chair and addressed the meeting on the welfare of engineers and on the creation of a National Department of Public Works.

On motion, duly seconded, the following resolution was adopted.

"Whereas, the American Society of Civil Engineers, is a member of Engineering Council, and

"Whereas, Engineering Council has created a committee on classification and compensation of engineers—State and Municipal Sections, and

"Whereas, the report of this committee to be effective and helpful to the profession, should be completed in the shortest possible time and made available for the use of those engaged in State and Municipal work, while the annual appropriations are under consideration by the executive and legislative authorities.

"Therefore, Be It Resolved, that the Pittsburgh Association of Members of the American Society of Civil Engineers request the Board of Direction of the Parent Society to urge upon the said committee through Engineering Council the necessity of the completion and publication of its report at the earliest possible date."

On motion, duly seconded, the Secretary was instructed to send copies of this resolution to each Local Association of the Society and to the Board of Direction.

On motion, duly seconded, the following recommendation was approved and ordered to be transmitted to the Engineering Conference on a National Department of Public Works:

> "It is recommended that the influence of the entire membership of the Society be directed toward the creation of a federal department of Public Works, the secretary of which shall be technically qualified and a member of the President's cabinet, and that the law creating such department shall provide for the co-ordination of all government engineering problems."

Adjourned.

Portland (Ore.) Association Organized 1913.

E. Burslem Thomson, President; C. P. Keyser, Secretary, 318 City Hall, Portland, Ore.

The Annual Meeting of the Association is held on the second Friday in January. Other meetings are called by the President and are usually convened on Friday evenings. The place is not fixed, but this information may be obtained on application to the Secretary. All members of the American Society of Civil Engineers are cordially invited to attend the meetings.

(Abstract of Minutes of Meeting)

September 26th, 1919.—The meeting was called to order at the University Club; President Thomson in the chair; C. P. Keyser, Secretary; and present, also, 13 members.

The minutes of the meetings of the Association of August 12th, 1919, and of the Board of Direction of September 12th, 1919, were read and approved.

A communication from R. W. Barnes, Secretary of the Local Chapter of the American Association of Engineers, was read, together with two resolutions passed by the Chapter, pertaining, respectively, to the question of the use of the union label on plans of architects and engineers, and to the Jones-Reavis Bill for a National Department of Public Works. On motion, duly seconded, it was voted that the Association favors a protest against the use of the union label on engineering and architectural drawings, that a Committee be appointed to draft a resolution to that effect, and that copies of this procedure be forwarded to the Oregon Chapter of the American Association of Engineers and the American Institute of Architects. President Thomson appointed Secretary Keyser as a committee of one to carry out this motion.

President Thomson outlined the salient features of the Jones-Reavis Bill, and, on motion, duly seconded, it was voted that the Association go on record as favoring the adoption of the Bill, and that a committee of three, Messrs. Hoffmark, Clarke, and Haselton, be instructed to draw up resolutions in support of the Local Campaign Committee appointed by Engineering Council.

The Secretary was ordered to advise Mr. Barnes of the action of the Association in these matters.

A communication from Mr. George C. Mason was read, recommending that, as the membership individually is being asked by the

Board of Direction of the Society for suggestions for the Nominating Committee, the Association nominate a candidate from this district and ask the support of its members for that candidate. The name of Mr. J. C. Stevens was suggested, and, on motion, duly seconded, the Secretary was instructed to recommend Mr. Stevens' name to the Oregon members of the Society and endeavor to enlist the support of the Spokane and Seattle Associations in the matter.

President Thomson read a letter from M. O. Leighton, Chairman of the National Service Committee of Engineering Council, promising to send to the Association copies of the bulletins of that Committee as issued.

Mr. M. E. Reed presented a progress report of the delegates of the Association to the Conference on Local Technical Co-operation.

Mr. B. S. Morrow, who served as Captain of Engineers with the American Expeditionary Forces, addressed the meeting on his experiences and on some engineering features of his work in France.

Mr. E. I. Cantine also addressed the meeting on the work of wooden shipbuilding with which he was connected during the war.

Adjourned.

St. Louis Association, Organized 1888 (Constitution Approved by Board, 1914).

J. A. Ockerson, President; C. W. S. Sammelman, Secretary-Treasurer, 300 City Hall, St. Louis, Mo.

The Annual Meeting of the Association, for the election of officers and for the transaction of business, is held on the fourth Monday in November. Two meetings each year, for the presentation and discussion of technical papers, are held in the Auditorium of the Engineers' Club of St. Louis and are open to members of the Associated Societies. Other "get-together" meetings are held regularly for dinner or luncheon on the fourth Monday of each month except July, August, and November.

San Diego Association, Organized 1915.

W. C. Earle, President; R. C. Wueste, Secretary-Treasurer, Bonita, Cal.

Seattle Association, Organized 1913.

L. M. Grant, President; G. A. Collins, Secretary, 1317 L. C. Smith Building, Seattle, Wash.

The regular meetings of the Association, with luncheon, are held at the Engineers' Club, Arctic Building, Third Avenue and Cherry Street, at 12.15 P. M., on the last Monday of each month. Informal luncheons are also held at 12.15 P. M. every Monday at the Engineers' Club.

Special evening meetings are held from time to time for the purpose of discussing important topics, and information concerning these meetings may be had by addressing the Secretary. All members in any grade of the American Society of Civil Engineers are cordially invited to attend the meetings when in the vicinity, and, if located in this District for any length of time, their membership in the Association will be appreciated.

Southern California Association, Organized 1914.

George G. Anderson, President; Floyd G. Dessery, Secretary, 511 Central Building, Los Angeles, Cal.

The Southern California Association of Members of the American Society of Civil Engineers (Los Angeles, Cal.) holds regular monthly meetings on the second Wednesday of each month, the December meeting being the Annual Meeting.

Informal luncheons in connection with the Joint Technical Societies of Los Angeles are held at 12.15 P. M., every Thursday at the Broadway Department Store Café.

The by-laws of the Association provide for the extension of hospitality to any member of the Society who may be temporarily in Los Angeles, and any such member will be gladly welcomed as a guest at any of the meetings or luncheons.

(Abstract of Minutes of Meetings)

September 10th, 1919.—The meeting was called to order at Christopher's Café, at 7.35 P. M.; President George G. Anderson in the chair; F. G. Dessery, Secretary; and present, also, 23 members and 8 guests.

The minutes of the meeting of July 9th, 1919, were read and approved.

A letter from Mr. K. D. Schwendener was read, stating that J. J. Bacus, City Building Inspector, desired the advice and co-operation of the Association in the matter of building regulations and laws. After discussion by Messrs. Thomas and Schwendener, the matter was referred, on motion, duly seconded, to the Board of Directors with power to create a permanent committee to co-operate and advise with the Chief Building Inspector.

The Secretary presented a letter from Mr. C. E. Grunsky, of San Francisco, Cal., calling attention to the efforts being made to create a National Board of Public Works, and stating that the bill before Congress needs the urgent support of every engineer, the engineers of California being expected to contribute $2 900 toward a fund of $100 000 to be used in forwarding the creation of such a National Board.

After discussion by Messrs. Hawgood and Beanfield, on motion, duly seconded, the Board of Directors was authorized to prepare resolutions to be sent to all Senators and Representatives and to circularize the Association for financial assistance.

Resolutions from the Directors of the San Francisco Association, the Joint Committee of the Technical Societies of Los Angeles, and the Joint Council of Engineering Societies of San Francisco, addressed to Governor Stephens, relative to filling a vacancy on the California State Water Commission, were read, and, on motion, duly seconded, the Board of Directors was authorized to draw up suitable resolutions to be forwarded to the Governor.

Mr. F. D. Howell called the attention of the Association to the proposal of the County Health Officer, Dr. Pomeroy, relative to the desirability of having the Supervisors create a County Board of Sanitary Engineers. On motion, duly seconded, President Anderson appointed Messrs. Woodard, Reed, and Dessery, an Advisory Sanitary Committee to meet with Dr. Pomeroy.

President Anderson gave a preliminary account of the meeting of the Conference Committee at Montclair, N. J., on the work of the Committee on Development.

The reports of the various Sub-Committees were made by:

Mr. E. R. Bowen, for the Sub-Committee on External Relations, with discussion by Messrs. Bowen, Howell, Anderson, and Beanfield.

Mr. F. R. Bates, for the Sub-Committee on Internal Relations, with discussion by Messrs. Anderson, Bates, Hawgood, Sheibley, and Thomas.

Professor F. Thomas, for the Sub-Committee on Technical Activities, with discussion by Messrs. Anderson and Reed.

Mr. B. Moody, for the Sub-Committee on Relation to Public Affairs, with discussion by Mr. Anderson.

President Anderson then made a detailed report of the Montclair meeting of the Conference Committee, consisting of three members from each of the Founder Societies and a representative of Engineering Council, at which meeting approval was given to the National Engineering Council and State Council.

On motion, duly seconded, a vote of thanks was tendered the members of the various Sub-Committees of the Association for their efforts and help.

On motion, duly seconded, a rising vote of thanks was given President Anderson for his untiring efforts and accomplishments for the Committee on Development.

On motion, duly seconded, the reports of the Sub-Committees were approved and adopted as the sentiments of the Association for President Anderson to present to the Committee on Development.

Adjourned.

October 15th, 1919.—The meeting was called to order at 8 P. M., at Christopher's Cafe; President George G. Anderson in the chair; F. G. Dessery, Secretary; and present, also, 34 members and 16 guests.

The minutes of the meeting of September 10th, 1919, were read and approved.

A letter from Mr. J. W. Kemp, Chairman of the Building Ordinance Revision Committee of the Los Angeles Chamber of Commerce, was read, and, on motion, duly seconded, was referred to the Committee on Building Laws and Regulations of the Association.

The Secretary read a letter and resolution from the Pittsburgh Association, calling on the Committee on Classification and Compensation of Engineers of Engineering Council, to complete its labors and make its report available to engineers engaged in public work while the annual appropriations are being considered by the various authorities. On motion, duly seconded, the correspondence was ordered filed.

The attention of the members present was called to a notice of the 106th regular meeting of the Colorado Association, which contains an interesting sidelight on the difficulties encountered in Colorado with the Engineers' License Law, now effective there, and its unsatisfactory operation.

Mr. Wilkie Woodard, Chairman of the Sanitary Committee, reported on the results of conferences with the County Health Officer. On motion, duly seconded, it was decided that, in the future, this

Committee will be merged with a similar committee of the Joint Technical Societies, or co-operate with this latter committee.

Mr. Samuel Storrow called the attention of members of the Association to the City Planning Commission, and suggested that a committee be appointed from the Association. The suggestion was made that a committee from the Joint Technical Societies would be more effective, and, on motion, duly seconded, it was decided to hold the appointment of such a committee in abeyance.

Mr. C. T. Leeds addressed the meeting on Universal Military Training, and presented a resolution that a committee of seven members be appointed to report to the Association on the subject. After discussion by Messrs. Woodard, Storrow, Trask, and Anderson, the resolution, on motion, duly seconded, was adopted, and President Anderson was instructed to appoint the committee.

Treasurer Ralph J. Reed reported the receipt of $62 from members toward the campaign for the National Department of Public Works.

A paper by Messrs. C. E. Tait and Willis S. Jones, entitled "Spreading Flood Waters as Related to Flood Control," was presented, and the subject was discussed by Messrs. Sonderegger, Jones, Barnard, Code, Pratt, Storrow, Sopp, Trask, and Strong. The discussion proved of such interest that it was suggested that the Programme Committee continue it at an early date.

President Anderson presented excerpts from the Report of the Committee on Development.

Adjourned.

November 12th, 1919.—The meeting was called to order at Christopher's Cafe, at 7.45 P. M.; Vice-President H. W. Dennis in the chair; F. G. Dessery, Secretary; and present, also, 30 members and 9 guests.

The minutes of the meeting of October 15th, 1919, were approved as printed in the *Bulletin* for November, 1919.

Mr. C. T. Leeds, Chairman of the Committee on "Universal Military Training" presented the report of that Committee, and, on motion, duly seconded, the report was approved and adopted.

Vice-President Dennis and Mr. Harry Hawgood called the attention of the members to the final report of the Committee on Development of the Society and the necessity of careful study thereof by the members.

Mr. Hawgood addressed the meeting briefly relative to the next Annual Convention of the Society, which is to be held in District No. 11, in May or June, 1920, and, by unanimous vote of those present, Los Angeles was chosen as the place for the Convention by the meeting.

On motion, duly seconded, Vice-President Dennis appointed the following members as a "Committee on Ways and Means 1920 Convention": Messrs. G. G. Anderson, Chairman, H. W. Dennis, W. K. Barnard, H. Hawgood, L. C. Hill, R. J. Reed, W. Mulholland, J. B. Lippincott, C. T. Leeds, W. H. Code, T. D. Allin, S. Storrow, B. Moody, and F. G. Dessery.

In continuation of the "Flood Control" studies, Mr. Hawgood presented a paper entitled "Cost of Flood Damage and Economic

Relations," which was discussed by Messrs. Robinson, Barnard, Glass, Reed, Dennis, Olmsted, Allin, Leeds, Sawyer, Sheibley, and Dessery.

On motion, duly seconded, County Flood Control Engineer Regan and his Assistant, Mr. Glass, were thanked for copies of the "Flood Control Report" presented to the Association.

Adjourned.

Spokane Association, Organized 1914.

Harold J. Doolittle, President; Charles E. Davis, Secretary, City Engineer's Office, Spokane, Wash.

The regular meetings of the Association are held on the second Friday of each month, except July and August. The hour and place of meeting are not fixed, but this information will be furnished on application to the Secretary.

Visiting members are invited to attend the meetings.

Texas Association, Organized 1913.

Hans Helland, President; E. N. Noyes, Secretary, Dure Building, Dallas, Tex.

Utah Association, Organized 1916.

A. B. Villadsen, President, 304 Dooly Bldg., Salt Lake City, Utah.

The Annual Meeting of the Association is held on the first Wednesday in April. The time of other meetings is not fixed, but this information will be furnished on application to the President.

MINUTES OF MEETINGS OF SPECIAL COMMITTEES TO REPORT UPON ENGINEERING SUBJECTS

Special Committee to Codify Present Practice on the Bearing Value of Soils for Foundations, etc.

September 25th, 1919.—The meeting was called to order at Society Headquarters. Present, Robert G. Cummings (Chairman), J. C. Meem, and E. G. Haines (Secretary *pro tem.*).

The meeting was devoted to a review of the past work of the Committee, with a view to resuming active work.

The manner of classifying soils was discussed, and it was agreed that certain modifications should be made, in order to make the classification more adaptable to the use of engineers, by regrouping certain headings.

The list of popular definitions of classes of soils, compiled by Mr. Haines, with modifications suggested by Mr. Cummings, was presented, and it was decided to wait for a final decision on the technical definitions and present both classes of definitions to the Society together.

Mr. Cummings reported that the work of the Bureau of Standards, under the direction of Dr. Griffiths, in conjunction with the work of the Soils Committee, was practically suspended at present.

Mr. Haines promised to present by December 1st, 1919, in form for publication, the drawings of the practical soils testing machine.

A diagram showing the allowable loads on different soils, being the mean values of a large number of building codes of different cities, was presented, and it was agreed that it should be included in the report of the Committee for the year, as being of interest to the Society.

The list of ways in which soil foundations give trouble was further discussed, and it was decided to submit Mr. Hazen's revised list to all members of the Committee for further comments.

Special Committee on Stresses in Railroad Track

March 19th, 1919.—The meeting was held at Chicago, Ill. Present, A. N. Talbot (Chairman),. A. S. Baldwin, G. H. Bremner, W. J. Burton, Charles S. Churchill, W. C. Cushing, George W. Kittredge, C. G. E. Larsson, G. T. Ray, F. E. Turneaure, J. E. Willoughby, C. D. Gennett, Jr. (representing Robert W. Hunt), and Mr. Bronson (representing Dr. P. H. Dudley, a member of the Committee of the American Railway Engineering Association).

The Chairman made a report on the work done on tests on the effect of counter-balance on the Illinois Central Railroad and on the action of ties on the Illinois Central Railroad and the Chicago, Milwaukee, and St. Paul Railroad.

After a general discussion of the progress of the work and of future plans, it was agreed to hold a meeting after the material on hand had been put in form for presentation to the Committee.

October 27th–28th, 1919.—The meetings were held at Chicago, Ill. Present, A. N. Talbot (Chairman), A. S. Baldwin, G. H. Bremner, W. J. Burton, Charles S. Churchill, W. C. Cushing, W. M. Dawley, C. D. Gennett, Jr. (representing Robert W. Hunt), J. B. Jenkins, George W. Kittredge, Paul M. LaBach, C. G. E. Larsson, G. J. Ray, H. R. Safford, J. E. Willoughby, and Mr. Bronson (representing Dr. P. H. Dudley). There were present, also, Messrs. M. L. Enger, N. E. Ensign, and E. E. Cress, who had been engaged in the testing work.

The tentative draft of the Second Progress Report of the Committee was discussed in detail, and modifications were made.

On motion, duly seconded, the Chairman was authorized to prepare the introductory matter and to present the report to the Society and to the American Railway Engineering Association as a progress report of the Committee.

Plans for future work were also discussed.

PRIVILEGES OF ENGINEERING SOCIETIES EXTENDED TO MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

Members of the American Society of Civil Engineers will be welcome in the Reading Rooms and at the meetings of many engineering societies in all parts of the world. A list of such societies will be found on pages 41 and 42 of the Year Book of the Society for 1919.

NEW BOOKS*

(From September 1st to December 1st, 1919)

The statements made in these notices are taken from the books themselves, and this Society is not responsible for them.

DONATIONS TO ENGINEERING SOCIETIES LIBRARY

PAPERS ON THE DESIGN OF ALTERNATING CURRENT MACHINERY.

By C. C. Hawkins, S. P. Smith and S. Neville. Lond. and N. Y., Sir Isaac Pitman and Sons, Ltd., 1919. 392 pp., illus., pl., tab., 9 x 6 in., cloth. 18 shillings.

Originating out of many discussions on technical subjects, the papers here collected find a connecting link in their common purpose, which is to deal scientifically and practically with problems arising in the design of alternating-current machinery. The point of view throughout is that of the practical designer. Contents: Notes on the Theory and Design of Alternating-Current Generators; The Flux Wave-Form of the Turbo-Alternator with Cylindrical Rotor; Magnetic Calculations for Tapered Teeth; Notes on the Theory and Design of the Polyphase Induction Motor.

THE PRINCIPLES OF ELECTRIC WAVE TELEGRAPHY AND TELEPHONY.

By J. A. Fleming. 4th Edition. Lond. and N. Y., Longmans, Green and Co., 1919. 707 pp., illus., pl., tab., 9 x 6 in., cloth. $14.00.

Dr. Fleming's well-known treatise has been again revised by additions which bring it up to date, while antiquated matter has been deleted in order that the volume might not become unwieldy. The book is a statement of principles rather than a full account of actual apparatus, and is intended to provide a comprehensive view of the subject, particularly with regard to its scientific side, and of that part of it which is concerned with quantitative measurements and the underlying theory.

PRACTICAL WINDINGS OF ALTERNATING-CURRENT MACHINERY.

By J. Herbert Wickman. Milwaukee, The Author. 36 pp., 9 x 6 in., paper. $1.00.

This pamphlet is intended to give the necessary information to armature winders, without mathematical calculations or theoretical discussions. Directions for winding, reconnecting for other voltages, or changing the windings from one phase to another, are given.

PRINCIPLES OF DIRECT-CURRENT MACHINES.

By Alexander S. Langsdorf. (Electrical Engineering Texts.) 2d Edition. N. Y., McGraw-Hill Book Company, Inc.; Lond., Hill Publishing Company, Ltd., 1919. 460 pp., 314 illus., 8 x 6 in., cloth. $4.00.

This book has been prepared to place before students of electrical engineering a reasonably complete treatment of the fundamental principles underlying the design and operation of all types of direct-current machinery. Instead of attempting to touch the "high spots" in the whole field of direct-current engineering, attention has been concentrated on certain important features which are ordinarily dismissed with brief mention, but which, the author believes, are vital to a thorough grasp of the subject. The present edition has been thoroughly revised and enlarged in accordance with the results of experience in the use of the book.

ELEMENTS OF RADIO-TELEGRAPHY.

By Ellery W. Stone, N. Y., D. Van Nostrand Co., 1919. 267 pp., 125 illus., 33 pl., 8 x 5 in., flexible cloth. $2.50.

This book, by the instructor at the United States Naval Radio Station, San Diego, Cal., was written primarily for use in instruction at that school; it is believed, however, that it will be helpful in other schools and for self instruction. The physical, rather than the mathematical presentation, of the subject is used. A knowledge of physics and mathematics is not necessary. Prominence is given to the development of the subject as illustrated by patents.

*Unless otherwise specified, books in this list have been donated by the publishers.

MARINE GAS ENGINES:

Their Construction and Management. By Carl H. Clark. 2d Edition. N. Y., D. Van Nostrand Co., 1919. 136 pp., 102 illus., 8 x 5 in., flexible cloth. $2.00.

This volume is a small manual of convenient size, intended for those who desire a systematic presentation of the principles of operation and construction of the standard types of marine gas engines, from a practical, rather than a theoretical point of view. The present edition has been revised to conform with current practice, and material on oil and Diesel engines has been added.

AIR NAVIGATION:

Notes and Examples. By Capt. S. F. Card. N. Y., Longmans, Green & Co.; Lond., Edward Arnold, 1919. 140 pp., illus., tab., map, 9 x 6 in., cloth. $3.40.

An elementary textbook of navigation for airplane pilots, which presents the methods and the course of instruction used in training the officers of the British flying services.

CHILTON TRACTOR INDEX, JULY, 1919:

Published Semi-Annually by the Chilton Co., Phila. 500 pp., 10 x 7 in., paper. $1.00.

This volume is a directory of the American tractor industry, in which, the editors state, they have attempted to present all the information useful to the industry as a whole. It includes descriptions of power farm machinery, illustrated descriptions and specifications of tractors and farm implements, and directories of manufacturers of implements, tractors, parts, and accessories.

DYKE'S AUTOMOBILE AND GASOLINE ENGINE ENCYCLOPEDIA.

By A. L. Dyke. 10th Edition. St. Louis, The Author (copyright, 1919). 940 pp., illus., 10 x 7 in., cloth. $5.00.

It is difficult to imagine any topic connected with the use or repair of automobiles, which is not discussed in this comprehensive volume for repairmen and operators. Theoretical considerations are omitted, but an immense amount of practical information is supplied in concise, definite form, illustrated by numerous drawings and charts. In addition to passenger automobiles, the volume treats of trucks, tractors, motorcycles, and airplanes.

STEAM TURBINES:

A Practical and Theoretical Treatise for Engineers and Students, Including a Discussion of the Gas Turbine. By James Ambrose Moyer. 4th Edition, Revised and Enlarged. N. Y., John Wiley and Sons, Inc.; Lond., Chapman and Hall, Ltd., 1919. 496 pp., illus, diag., tab., 1 folded chart, 9 x 6 in., cloth. $4.00.

This edition differs from the preceding ones by containing fuller discussions of the methods of governing, the calculation of the strength of disk type blade wheels, and of recent developments in marine practice. The text as a whole has also been revised. The general purpose of the volume is to provide the designer, operator, or manufacturer of steam turbines with a concise manual of information, based on practical experience.

THE GASOLINE AUTOMOBILE.

Prepared in the Extension Division of the University of Wisconsin, by George W. Hobbs and Ben G. Elliott. 2d Edition, Completely Revised by Ben G. Elliott and Earl L. Consoliver. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Publishing Co., Ltd., 1919. 483 pp., illus., 1 pl., 9 x 6 in., cloth. $3.00.

Developments in automobile practice during the past four years have necessitated changes in this popular textbook. In addition to the necessary revision, the book has been rewritten, and enlarged by the inclusion of several new chapters. In doing this, the authors have provided a work on the fundamental principles of automobile design, construction, and operation for the instruction of those who drive, repair, sell, or otherwise have to do with motor cars.

CATALYSIS IN INDUSTRIAL CHEMISTRY.

By G. G. Henderson. Lond. and N. Y., Longmans, Green & Co., 1919. 202 pp., 9 x 6 in., cloth. $3.25.

This, the latest volume of the series of Monographs on Industrial Chemistry which is being published under the editorship of Sir Edward Thorpe, is intended to present broadly the present knowledge of the phenomenon of which it treats. The book reviews the existing literature on catalysis, paying particular attention to the many and varied applications now used in industry. The author hopes that it will also suggest the desirability of further investigations.

COMMERCIAL OILS: VEGETABLE AND ANIMAL;

With Special Reference to Oriental Oils. By I. F. Laucks. N. Y., John Wiley and Sons, Inc.; Lond., Chapman and Hall, Ltd., 1919. 138 pp., 8 x 5 in., cloth. $1.25.

This book is intended to give men without technical training, who are in the oil trade, the technical data and information required in every-day dealings, in concise form. The various commercial oils are listed. For each are given the sources, uses, and the physical and chemical characteristics. The values have been collected from the standard texts, supplemented, particularly in regard to Oriental oils, by the results obtained in the author's laboratory.

OXY-ACETYLENE WELDING MANUAL.

By Lorn Campbell, Jr. (Wiley Engineering Series.) N. Y., John Wiley & Sons, Inc.; Lond., Chapman & Hall, Ltd., 1919. 154 pp., 92 illus., 1 pl., 8 x 5 in., cloth. $1.25.

An instruction book for beginners by the officer in charge of welding instruction in the Ordnance Department, U. S. A. The work is confined to shop practice, and is intended to provide a systematic, standardized method of instructing, adapted to class use, and as a reference book in the shop.

IRON AND STEEL:

A Treatise on the Smelting, Refining, and Mechanical Processes of the Iron and Steel Industry, Including the Chemical and Physical Characteristics of Wrought Iron, Carbon, High-Speed and Alloy Steels, Cast Iron, and Steel Castings, and the Application of These Materials in Machine and Tool Construction. By Erik Oberg and Franklin D. Jones. N. Y., The Industrial Press; Lond., The Machinery Publishing Co., Ltd., 1918. 328 pp., illus., 9 x 6 in., cloth. $2.50.

This volume, the authors state, is not intended as a treatise for metallurgists and those engaged in the manufacture of iron and steel, but as a textbook for students in technical schools and those engaged in mechanical engineering and machine building. The book provides for these a broad, general survey of the industry, with definite practical information on the various commercial grades and forms of iron and steel products, and the particular class of service for which each is suitable.

FOUNDRY PRACTICE:

A Textbook for Molders, Students, and Apprentices. By R. H. Palmer. 2d Edition. N. Y., John Wiley & Sons, Inc.; Lond., Chapman & Hall, Ltd., 1919. 390 pp., illus., 40 tab., 8 x 6 in., cloth. $3.00.

This volume is intended primarily for purposes of instruction, rather than as a treatise for experienced foundrymen. The various types of moulds are explained, and illustrations of the different practices are given. Cupola and air-furnace practice, foundry equipment, and methods of mending and cleaning castings are also discussed. This edition has been enlarged by the inclusion of methods for casting and moulding a number of additional articles, such as engine cylinders, propellers, lathe beds, and large kettles.

THE METALS OF THE RARE EARTHS.

By J. F. Spencer. Lond. and N. Y., Longmans, Green & Co., 1919. 279 pp., diagrams, tab., 9 x 6 in., cloth. $4.50.

This volume supplies a review of our knowledge of these metals, in which their occurrence, separation, compounds, and uses are described. An extensive list of references is included, which contains, the author believes, all the important papers published on the subject, as well as most of those of lesser importance.

THE PHYSICAL CHEMISTRY OF THE METALS.

By Rudolph Schenck. Translated and Annotated by Reginald Scott Dean. N. Y., John Wiley and Sons, Inc.; Lond., Chapman & Hall, Ltd., 1919. 239 pp., illus., tab., 9 x 6 in., cloth. $3.00.

This volume is the outcome of a course of lectures delivered in the Technischen Hochschule at Aachen before the engineers of the district. The purpose of the lectures was to show the use of chemical statics and to explain the applications of physical chemistry in the study of smelting operations and metallurgical processes. The translator has made additions to the original text when necessary and has revised the numerical data to agree with the accepted values.

THE ANALYSIS OF MINERALS AND ORES OF THE RARER ELEMENTS;

For Analytical Chemists, Metallurgists, and Advanced Students. By W. R. Schoeller and A. R. Powell. Lond., Charles Griffin & Co., Ltd.; Phila., J. B. Lippincott Co., 1919. 239 pp., tab., 9 x 6 in., cloth. 16 shillings. (Gift of J. B. Lippincott Co.)

This is a practical laboratory guide for those interested in the determination of the so-called rare elements, and is the first work, the authors state, in which the complete analysis of the minerals of these elements has received systematic treatment. The methods have been selected from various authorities, supplemented when necessary by methods devised by the authors. Full details are given in each case.

FIFTY YEARS OF IRON AND STEEL.

By Joseph G. Butler, Jr. Cleveland, The Penton Press, 1919. 145 pp., por., 10 x 6 in., leather. (Gift of Author.)

This volume is one of a special edition, limited to 100 copies, of an address delivered before the American Iron and Steel Institute in 1917, in which the author gives his personal reminiscences of the development in iron and steel making, as observed during an active participation in the industry in Eastern Ohio, which began in 1857. To this are added some brief data on the early history of iron and steel, and a chapter on the activities of the American iron manufactures during the great war. The volume is profusely illustrated with portraits of men of note in the industry.

THE STRATEGY OF MINERALS:

A Study of the Mineral Factor in the World Position of America in War and in Peace. Edited by George Otis Smith, with an Introduction by Franklin K. Lane. N. Y. and Lond., D. Appleton & Co., 1919. 372 pp., 8 x 5 in., ¼ cloth. $2.50.

The part played by minerals in the World War and their share in reconstruction are discussed in this volume by a group of geologists in the Government service. The strategic value of mineral resources of the United States in the larger re-organization of peace is taken up, along with the problems of their utilization and conservation. Contents: International Relations and Economic Minerals; The Shipping Crisis; Mineral Fuels; Tendencies of Power Production; Iron and Its Associates; Copper; Lead and Zinc; Minor Metals; Minerals in the Chemical Industries; Other Industrial Minerals; Position of the United States Among the Nations; A Case of National Dependence; Germany; A Look Ahead; War-Time Control of Minerals.

ASBESTOS:

From Mine to Finished Product. N. Y., Asbestos and Mineral Corporation, 1919. 194 pp., 60 pl., 11 x 10 in., cloth.

A collection of sixty photographs of asbestos minerals, mines, and manufacturing plants, forming a pictorial presentation of the mining of raw asbestos and its manufacture into finished goods. Brief explanatory notes accompany the illustrations.

OSMOTIC PRESSURE.

By Alexander Findlay. 2d Edition. Lond. and N. Y., Longmans, Green and Co., 1919. 116 pp., illus., tab., 9 x 6 in., cloth. $2.15.

The author of this monograph gives an account of the theories of osmotic pressure, the methods of determining it, and the general theory of solutions. An extensive bibliography is included. In preparing this new edition, account has been taken of the results obtained by investigators during the past six years.

GEODESY:

Including Astronomical Observations, Gravity Measurements, and Method of Least Squares. By George L. Hosmer. N. Y., John Wiley & Sons, Inc.; Lond., Chapman & Hall, Ltd., 1919. 368 pp., illus., tab., 9 x 6 in., cloth. $3.50.

The author has endeavored to produce a textbook adapted to a course of moderate length, which would make clear the underlying principles and emphasize the theory as well as the details of field work. The methods of observing and computing given are consistent with the practice of the U. S. Coast and Geodetic Survey.

OPPORTUNITIES IN CHEMISTRY.

By Ellwood Hendrick. N. Y. and London, Harper and Brothers, 1919. 102 pp., 8 x 5 in., boards. 75 cents.

This little volume attempts to explain the relation of chemistry to our activities in general and the usefulness of chemical knowledge in various walks of life. It will serve to introduce the subject to those considering its possibilities as a profession.

THE CONDENSED CHEMICAL DICTIONARY:

A Reference Volume for All Requiring Quick Access to a Large Amount of Essential Data Regarding Chemicals, and Other Substances Used in Manufacturing and Laboratory Work. Compiled and Edited by The Editorial Staff of the Chemical Engineering Catalog. N. Y., The Chemical Catalog Company, Inc., 1919. 525 pp., 9 x 6 in., cloth. $5.00.

This volume has been prepared to meet the need for a concise summary of the properties of chemicals, which is felt by exporters, brokers, purchasing agents, manufacturers, and others who require quick access to information on chemical products. The arrangement of the book is alphabetical. The information given includes variant names, formulas, color and properties, constants (boiling and melting points, specific gravity, etc.), derivation, method of purification, grades obtainable, containers, uses, fire hazard, and shipping regulations. Substances made in America are indicated. The volume is fully cross-indexed, and includes a number of useful tables of weights and measures, thermometric scales, etc. Synthetic dyes are omitted. While the compilers state that no attempt has been made to be exhaustive, but merely to give the outstanding facts concerning the chemicals ordinarily met in commerce, approximately 6 000 substances are included.

MANUFACTURERS' INSTRUCTORS AND ADVISERS.

By Frederic Meron. N. Y., Theo. Audel & Co. (copyright, 1918). 3 vol. and portfolio, cloth. $7.00.

The author endeavors to present concisely and clearly the results of his experience in the installation, organization, and operation of industrial plants, with the object of showing, by comparison and illustration, methods for increasing output and reducing expenses. Contents: Vol. 1, Layouts and Equipments for Factories; Vol. 2, Common Sense Working Methods in Factories; Vol. 3, The Human Element in Organizations.

THE OUTLOOK FOR RESEARCH AND INVENTION:

With an Appendix of Problems Awaiting Solution. By Nevil Monroe Hopkins. N. Y., D. Van Nostrand Company, 1919. 241 pp., 1 pl., 6 por., 8 x 5 in., cloth. $2.00.

The object of this book is to stimulate a more general interest in American research, to indicate its necessity at this time, to explain the educational requirements for research workers, and to point out the ways in which such work is done inefficiently at present. Appended to the volume is a list of suggested lines of research.

PRACTICAL MATHEMATICS FOR HOME STUDY:

Being the Essentials of Arithmetic, Geometry, Algebra, and Trigonometry. By Claude Irwin Palmer. N. Y., McGraw-Hill Book Co., Inc.; Lond., Hill Publishing Co., Ltd., 1919, 493 pp., illus., tab., 8 x 5 in., cloth. $3.00.

During the past fifteen years the author has taught mathematics in the evening school at the Armour Institute of Technology to classes of men engaged in practical pursuits of various kinds. For this purpose a course of instruction was published in four volumes, which has now been arranged in one volume, with particular reference to the needs of home students. In the present edition, a few new topics have been added, together with many solutions of problems. The book includes arithmetic, geometry, algebra, logarithms, and trigonometry. It is intended for adult students, and the three thousand exercises and problems are selected to illustrate actual practical problems.

FOREST PRODUCTS:

Their Manufacture and Use, Embracing the Principal Commercial Features in the Production, Manufacture, and Utilization of the Most Important Forest Products Other than Lumber, in the United States. By Nelson Courtlandt Brown. N. Y., John Wiley and Sons, Inc.; Lond., Chapman and Hall, Ltd., 1919. 471 pp., 120 illus., 1 pl., tab., 9 x 6 in., cloth. $3.75.

The object of this book is to provide a brief account of the chief commercial features involved in the manufacture and use of such products as wood pulp and paper, tanning materials, veneers, cooperage, naval stores, distilled products, charcoal, maple sugar and syrup, dye woods, rubber, cork, excelsior, shingles, mine timbers, etc., which will serve as a text for students and as a book of reference. The volume reviews a field in which, the author states, but little has been written on American practice. Brief bibliographies are appended to the chapters.

A MANUAL OF PHYSICAL MEASUREMENTS.

By Anthony Zeleny and Henry A. Erikson. 4th Edition. 261 pp., 129 illus., tab., 8 x 5 in., cloth. $2.00.

This manual is an outline of the laboratory course given to students of general physics at the University of Minnesota. One hundred and thirty-three experiments are included. Directions for assembling the apparatus and performing the experiments are given. Appendixes give the mathematical tables needed by users of the book.

RETAINING WALLS:

Based Entirely on the Theory of Friction. By Pedro Dozal. Done into English by R. T. Mulleady. Buenos Aires, M. A. Rosas, 1918. 161 pp., 62 illus., 11 x 7 in., cloth. (Gift of Author.)

The author presents a general theory in regard to the static pressures acting on a plane cutting an unbounded coherent, incoherent, or liquid mass in equilibrium, and its application for the calculation of the pressures on retaining walls. The theory advanced differs from those presented by Rankine and other students of the subject and gives notably different results.

APPLIED MECHANICS:

Vol. II: Strength of Materials. By C. E. Fuller and W. A. Johnston. N. Y., John Wiley and Sons, Inc.; Lond., Chapman & Hall, Ltd., 1919. 556 pp., illus., 9 x 6 in., cloth. $3.75.

Vol. I of this textbook, treating of statics and dynamics, appeared several years ago. The present volume, treating of the strength of materials, covers the fundamentals of this subject, as taught in the Engineering Departments of the Massachusetts Institute of Technology, in so far as they are required in the study of structural and machine design and in the ordinary problems of engineering practice.

TRAITÉ DE MÉCANIQUE RATIONNELLE:

Vol. I, Statique—Dynamique du Point. By Paul Appell. 4th Edition. Paris, Gauthier-Villars et Cie., 1919. 619 pp., 10 x 7 in., paper. 36 francs.

The treatise of which this book forms the first volume is a comprehensive one, covering the course given for many years in the Faculté des Sciences of Paris. The first volume includes the theory of vectors, statics, and the dynamics of particles. The present edition has been thoroughly revised and references to recent writings on the subject have been added. No previous knowledge of mechanics is assumed. The work is designed to give a thorough understanding of present knowledge of mechanics to those studying the subject in preparation for an engineering career.

CONCRETE-STEEL CONSTRUCTION:

Part I, Buildings: A Treatise Upon the Elementary Principles of Design and Execution of Reinforced Concrete Work in Buildings. By Henry T. Eddy and C. A. P. Turner. 2d Edition. Minneapolis, C. A. P. Turner and Co., 1919. 477 + 25 pp., illus., tab., 9 x 6 in., cloth. $10.00.

The authors of this volume believe that the fundamental principles underlying the theory of reinforced construction are not generally understood by engineers, and that the methods of computation of applied bending moments in common use are erroneous. Their book presents what they believe to be the correct analysis of the bending and twisting moments present in columns and flat slabs, a method founded on the manner of distribution of the vertical shears that transmit the loading to the supports.

AUTOMATIC SPRINKLER PROTECTION.

By Gorham Dana. 2d Edition. N. Y., John Wiley and Sons, Inc.; Lond., Chapman and Hall, Ltd., 1919. 456 pp., illus., 9 x 5 in., cloth. $3.50.

The author of this volume has attempted to cover the subject in such a way that his book may serve as a textbook for students and also as a reference book for experienced engineers. Starting with a historical summary of the development of the art, he then describes the tests and characteristics of sprinklers, installation rules, layouts, valves, supervisory systems, etc. An Appendix lists all types on which information is available and summarizes more than 6 000 tests of various sprinklers.

HAND-BOOK OF FIRE PROTECTION.

By Everett U. Crosby, Henry A. Fiske, and H. Walter Forster. 6th Edition. N. Y., D. Van Nostrand Company, 1919. 757 pp., illus., tab., 7 x 5 in., flexible cloth. $4.00.

This work has long been a standard reference book for insurance engineers and inspectors, in which those methods of fire protection which have crystallized into good practice are collected and presented concisely. The present edition has been enlarged by new chapters and illustrations, and has been carefully revised.

PRINCIPLES OF REINFORCED CONCRETE CONSTRUCTION.

By F. E. Turneaure and E. R. Maurer. 3d Edition, Revised and Enlarged. N. Y., John Wiley and Sons, Inc.; Lond., Chapman and Hall, Ltd., 1919. 485 pp., illus., diag., pl., tab., 9 x 6 in., cloth. $3.75.

Like former editions, this work is intended "to present in a systematic manner those principles in mechanics underlying the design of reinforced concrete; to present the results of all available tests that will aid in establishing coefficients in working stresses; and to give such illustrative material from actual designs as will serve to make clear the principles involved". In the present edition, the material has been considerably amplified and rearranged. Separate chapters have been devoted to the theory of flexure; bond and shear; and the design of beams. The experimental data have been reviewed. A new chapter on flat slabs has been added, and the chapter on building construction extended.

DONATIONS TO THE READING ROOM

DESCRIPTIVE GEOMETRY.

By Adam V. Millar, Edward S. Maclin, and Lorraine J. Markwardt. Madison, Wis., The Authors, 1919. 10 + 161 pp., 86 illus., 7¾ x 5¼ in., cloth. $2.00. (Gift of Tracy and Kilgore, Printers.)

In preparing this text, the authors, it is stated, have endeavored to present the subject in a simple, logical manner and in close conformity to commercial drafting practice, as well as to develop in the student the faculty of visualizing magnitudes in space. These objects have been attained by omitting the ground line, thus concentrating the student's attention on the object or magnitude in space and not on the planes of projection, by presenting the subject in the third quadrant, as practiced in drafting rooms, and by the extensive use of views other than top, end, or front views, in order to train the student's visualizing powers. The text also includes a system of miniature layouts for blackboard work and a co-ordinate system of presenting problems for drafting-room work.

FIELD ENGINEERING:

A Handbook of the Theory and Practice of Railway Surveying, Location, and Construction. By William H. Searles. 18th Edition. Rev. and Enl. by William H. Searles and Howard Chapin Ives. N. Y., John Wiley & Sons, Inc.; Lond., Chapman & Hall, Limited, 1919. 2 vol. in 1, 148 illus., 4 plates, 49 tab., 6¾ x 4¼ in., morocco. $3.00. (Gift of W. H. Searles.)

The first edition of this book was issued in 1880, and, in the preface to that edition, the author states that his object was to present the general subject of railway field work in progressive and logical order for the benefit of beginners, to classify the problems for ready reference, to discuss the important practical questions, to use a uniform and systematic notation, to express the resulting formula of every problem in the shape best adapted to convenient numerical computation, and to furnish a variety of useful tables adapted to the wants of the field engineer. Changes have been made in the various editions through which the book has passed, and the text has been re-arranged and many omissions, as well as additions of new and up-to-date matter, have been made, but the object of the book, as stated in the preface to the first edition, is still to comply with the need for a handbook for the railroad engineer in the field and the student in railway practice. The present edition includes, as new matter, the American Railway Engineering Association spiral, with an explanation of its application in practice.

THE DESIGN OF WALLS, BINS AND GRAIN ELEVATORS.

By Milo S. Ketchum. 3d Edition, Rev. and Enl. N. Y., McGraw-Hill Book Company, 1919. 19 + 556 pp., 304 illus., 2 folding plates, 40 tab., 9 x 6½ in., cloth. $4.00. (Gift of Author.)

The author's purpose, as stated, has been to present a systematic analysis of the stresses due to granular materials, together with a discussion on the principles of design and the details of structures which contain such materials, with costs. Much new matter has been added, which includes data on the economic design of

reinforced concrete retaining walls, formulas for wedge-shaped reinforced concrete beams and for calculating the load on bin walls and the unit pressures by Airy's solution, calculations of pressures in sand boxes, and fully worked out problems on the design of retaining walls and bins. The report of the American Railway Engineering Association on the design of retaining walls is also included, the adoption of which, it is stated, has defined, for the first time, a standard practice for retaining walls and abutments. The Appendices include specifications for reinforced concrete, stone masonry, and steel construction.

HYDROLOGY: THE FUNDAMENTAL BASIS OF HYDRAULIC ENGINEERING.

By Daniel W. Mead. N. Y., McGraw-Hill Book Company, Inc.; Lond., Hill Publishing Co., Ltd., 1919. 11 + 647 pp., 352 illus., 67 tab., $9\frac{1}{2}$ x 6 in., cloth. $5.00. (Gift of Author.)

Lack of knowledge of the fundamentals of hydrology and of the importance of hydrological factors has been responsible, the author believes, for more failures in hydraulic engineering projects than defects in structural design. To assist in removing this ignorance he has here set down some of the more important facts and principles, omitting everything that his long experience has not shown to be of practical importance. Carefully selected lists of references are appended to each chapter, to enable readers to complete their study of any phase of the subject, which has not been sufficiently treated within the limits of the book itself.

MEMBERSHIP

(From September 5th to December 3d, 1919)

ADDITIONS

MEMBERS		Date of Membership.
Archer, Augustus Rowley. Engr., Jacobs & Davies, Inc., 30 Church St., Room 1939, New York City	Assoc. M. M.	April 4, 1906 Sept. 9, 1919
Barnes, Warren Hammond. Senior Civ. Engr., Interstate Commerce Comm., Bureau of Valuation, Pacific Dist., 731 Wells Fargo Bldg., San Francisco (Res., 5839 Birch Court, Oakland), Cal.		Sept. 9, 1919
Bertin, René Leon. Care, White Constr. Co., 95 Madison Ave., New York City		Sept. 9, 1919
Black, Frank Laughton. Associated with A. H. Terry, 1777 Noble Ave., Bridgeport, Conn.		Oct. 14, 1919
Black, Roger Derby. With Hugh L. Cooper & Co., 101 Park Ave., New York City	Jun. Assoc. M. M.	Jan. 3, 1905 Jan. 7, 1913 Sept. 9, 1919
Blackwell, James Eustace. Archt., 1112 Harvard Ave., North, Seattle, Wash.		Sept. 9, 1919
Blum, Bernard. Engr., M. of W., N. P. R. R., 1210 Northern Pacific Railroad, St. Paul, Minn.		Oct. 14, 1919
Bock, Carl August. Secy., Morgan Eng. Cos., Dayton, Ohio	Jun. Assoc. M. M.	Aug. 31, 1909 Dec. 3, 1912 Sept. 9, 1919
Brown, Rodman Merritt. Chf. Engr. in Chg. of Bldg. Dept., City of Omaha (Res., 6719 Florence Boulevard), Omaha, Nebr.	Assoc. M. M.	Feb. 1, 1905 Sept. 9, 1919
Burnell, Eugene Dickinson. Constr. Engr., Adams, Evans & Co., 30 Church St., New York City	Assoc. M. M.	June 4, 1913 Sept. 9, 1919
Butler, Drury. County Surv., Sacramento County, Box 933, Sacramento, Cal.		Sept. 9, 1919
Cahill, James Edward. Structural Engr.; Civ. Engr. and Supt. of Constr., Great Lakes Dredge & Dock Co., 104 South Michigan Ave., Chicago, Ill.	Jun. Assoc. M. M.	Mar. 31, 1908 Oct. 3, 1911 Sept. 9, 1919
Carey, William Nelson. 1792 Princeton Ave., St. Paul, Minn.	Assoc. M. M.	Mar. 14, 1916 Oct. 15, 1919
Chisolm, Edward North, Jr. Maj., Engrs., U. S. A.; Chf., Purchase, Storage and Eng., Statistics Branch, Gen. Staff, Room 355, Office, Chf. of Staff, State, War, and Navy Bldg., Washington, D. C.		Oct. 14, 1919
Christhilf, August Ewaldt. Engr., Quinlan & Robertson, Inc., S. E. Cor. Gittings Ave. and Sycamore Rd., Baltimore, Md.		Sept. 9, 1919

MEMBERS (*Continued*)

		Date of Membership.
COPELAND, FREDERIC LUCIUS. Supt., Bates & Rogers Constr. Co., 875 Old Colony Bldg., Chicago, Ill.	Jun.	Nov. 5, 1907
	Assoc. M.	Jan. 31, 1911
	M.	Oct. 15, 1919
COTTRELL, CLARKE COPELAND. State Highway Engr., Carson City, Nev.	Assoc. M.	May 13, 1918
	M.	Sept. 9, 1919
COVELL, VERNON ROYCE. Deputy County Engr., Allegheny County, Room 301, Court House, Pittsburgh, Pa.	Assoc. M.	Mar. 7, 1906
	M.	Sept. 9, 1919
CRAM, CLYDE MAXWELL. U. S. Asst. Engr., U. S. Engr. Office, 725 Central Bldg., Los Angeles, Cal.		Sept. 9, 1919
CRONHOLM, FREDERICK N. Gen. Supt., River Div., Imperial Irrig. Dist., Andrade, Cal.	Assoc. M.	July 9, 1912
	M.	Sept. 9, 1919
CUDWORTH, FRANK EZEKIEL. Gen. Delivery, Dallas, Tex.		Oct. 14, 1919
DARLINGTON, EDWARD BRINTON. Chf. Engr., Twin Falls North Side Land & Water Co., Jerome, Idaho		Oct. 14, 1919
DAVIS, FRANK HILL. U. S. Asst. Engr., U. S. Engr. Office, Bankers Trust Bldg., Little Rock, Ark.	Assoc. M.	May 31, 1916
	M.	Oct. 15, 1919
DAWLEY, WALTER MANVILLE. Engr., Land and Tax Dept., Erie R. R., 15 Sylvan St., Rutherford, N. J.		April 14, 1919
DISBROW, CLARKSON ALCOTT. Asst. to Vice-Pres. and Secy., The Rail Joint Co., 61 Broadway, Room 3124, New York City		Oct. 14, 1919
DOWNS, WILLIAM SMITH. Div. Engr., West Virginia State Road Comm., 47 Euclid Ave., Morgantown, W. Va.		Oct. 14, 1919
DRESSER, ELBERT HERMON. 306 Sellwood Bldg., Duluth, Minn.		Sept. 9, 1919
DUNMIRE, ELIJAH HERBERT. Engr. (Black & Veatch), 507 Interstate Bldg., Kansas City, Mo.	Jun.	Mar. 5, 1907
	Assoc. M.	Oct. 3, 1911
	M.	Sept. 9, 1919
EDY, JOHN NORTH. Chf. Engr., State Highway Comm. of Montana, 310 Fifth Ave., Helena, Mont.	Jun.	Oct. 31, 1911
	Assoc. M.	April 2, 1913
	M.	Sept. 9, 1919
FALLIS, WILLIAM STUART. State Highway Engr., 918 Commercial Bank Bldg., Raleigh, N. C.		Sept. 9, 1919
FERGUSON, LEWIS REPP. 320 Widener Bldg., Philadelphia, Pa.	Jun.	Aug. 31, 1909
	Assoc. M.	Jan. 31, 1911
	M.	Oct. 15, 1919
FISHER, CHESTER CENTENNIAL. Engr., U. S. Reclamation Service, Denver, Colo.	Jun.	April 3, 1906
	Assoc. M.	Oct. 2, 1907
	M.	Sept. 9, 1919
FORREST, THOMAS EDWARD. Junior Engr., U. S. Engr. Dept., U. S. Engr. Office, Portland, Me.		Oct. 14, 1919
FREEMAN, MILTON HARVEY. Res. Engr., Public Service Comm., First Dist., Valhalla, N. Y.	Assoc. M.	July 1, 1909
	M.	Sept. 9, 1919

MEMBERS (*Continued*)

		Date of Membership.
FUCIK, EDWARD JAMES. Asst. Gen. Mgr., Great Lakes Dredge & Dock Co. (Res., 3852 North Hamlin Ave.), Chicago, Ill.	Assoc. M.	Oct. 2, 1907
	M.	Sept. 9, 1919
GARRIGUES, HENRY HAYDOCK. Div. Engr., Philadelphia Terminal Div., P. R. R., 32d and Powelton Ave., Philadelphia, Pa.	Jun.	Oct. 31, 1905
	Assoc. M.	June 30, 1910
	M.	Sept. 9, 1919
GORMAN, FRANK LEE. Designing Engr., Watson Eng. Co., 1101 Hippodrome Bldg., Cleveland, Ohio		Sept. 9, 1919
GREENWAY, JOHN OWEN. Engr., Washington Brick, Lime & Sewer Pipe Co., 1111 West 15th Ave., Spokane, Wash.	Assoc. M.	Jan. 17, 1916
	M.	Sept. 9, 1919
HALSTEAD, GEORGE ELIAS. Asst. to C. A. Wilson, 1119 Provident Bank Bldg., Cincinnati, Ohio	Jun.	June 30, 1911
	Assoc. M.	Mar. 2, 1915
	M.	Nov. 25, 1919
HAMLIN, RALPH. Structural Engr., Hewitt & Brown, 5129 Wentworth Ave., Minneapolis, Minn.	Jun.	Jan. 5, 1904
	Assoc. M.	Oct. 5, 1909
	M.	Oct. 15, 1919
HARDING, SIDNEY TWICHELL. Asst. Prof. and Associate Prof. of Irrig., Univ. of California, 307 Agricultural Hall, Berkeley, Cal.	Jun.	Sept. 5, 1905
	Assoc. M.	May 7, 1913
	M.	Oct. 15, 1919
HAYES, LUKE JOSEPH. Chf. Engr., Star Electrode Works, Niagara Falls (Res., Box 270, La Salle), N. Y.	Assoc. M.	Aug. 31, 1915
	M.	June 16, 1919
HENRICI, FREDERICK WILLIAM. Asst. Engr., Am. Bridge Co., Erecting Dept., 962 Kennebec St., Pittsburgh, Pa.		Oct. 14, 1919
HERSHEY, JOSEPH WILLIAM. Room 510, Columbia Bank Bldg., Pittsburgh, Pa.		Nov. 25, 1919
HODGSON, CAREY VANDERVORT. Chf. of Party, U. S. Coast and Geodetic Survey, Washington, D. C.		Nov. 25, 1919
JACKSON, JAMES GRANBERY. 220 Capitol Boulevard, Nashville, Tenn.		Oct. 14, 1919
JENSEN, CHRISTIAN PETER. County Surv., Fresno County; Chf. Engr., Fresno County Highways, 306 Cory Bldg., Fresno, Cal.	Assoc. M.	Jan. 31, 1911
	M.	Oct. 15, 1919
JONES, LEWIS ALLEN. Senior Drainage Engr., U. S. Bureau of Public Roads, 49 Chestnut St., Takoma Park, D. C.	Assoc. M.	Oct. 1, 1912
	M.	Oct. 15, 1919
JOY, THOMAS HITCHCOCK. Archt. Engr., S. Scott Joy, 2001 West 39th St., Chicago, Ill.		Oct. 14, 1919
KACKLEY, WALTER JOHN. Cons. Engr. (Klyce & Kackley), 721 Fourth and First National Bank Bldg., Nashville, Tenn.	Assoc. M.	Mar. 4, 1914
	M.	Sept. 9, 1919
KEYS, EDWARD ALLEN. Maj., Engrs., U. S. A., 2628 Munitions Bldg., Washington, D. C.	Assoc. M.	July 9, 1906
	M.	Sept. 9, 1919

MEMBERS (*Continued*)

		Date of Membership.
KNOWLES, JAMES HENRY. Chf. Engr., U. S. Railroad Administration, West. Pac. R. R., 926 Mills Bldg., San Francisco, Cal		Oct. 14, 1919
KYLE, RALPH BRIGGS. 202 Queen and Crescent Bldg., New Orleans, La	Assoc. M.	May 3, 1910
	M.	Oct. 15, 1919
LAMB, ERNEST AVERY. Res. Engr., Barge Canal Residency No. 4, 474 Madison Ave., Albany, N. Y.	Assoc. M.	Sept. 7, 1904
	M.	Sept. 9, 1919
LAMBERT, BYRON JAMES. Head of Dept., Structural Eng., State Univ. of Iowa, Iowa City, Iowa	Assoc. M.	Jan. 5, 1909
	M.	Sept. 9, 1919
LINENTHAL, MARK. Builder and Constr. Engr. (Gascoigne & Linenthal, Inc.), 43 Tremont St., Boston, Mass	Assoc. M.	Oct. 1, 1913
	M.	Oct. 15, 1919
LITTLEFIELD, MYRON GEORGE. Chf. Draftsman, McClintic-Marshall Constr. Co., Pottstown, Pa		Sept. 9, 1919
LOTTER, HENRY HOWELL. Senior Highway Engr., U. S. Bureau of Public Roads, 328 East McCarty St., Jefferson City, Mo.		Sept. 9, 1919
LOZIER, WILLIAM SHERMAN. Cons. Engr., Cutler Bldg., Rochester, N. Y.		Sept. 9, 1919
MADDOCK, THOMAS. State Engr. (Res., 323 North 2d St.), Phœnix, Ariz	Assoc. M.	June 24, 1914
	M.	Oct. 15, 1919
MAENNER, LUDWIG THEODORE. Office Engr., Mo. Pac. R. R., 1055 Ry. Exchange Bldg., St. Louis, Mo		Oct. 14, 1919
MARTINEZ Y RENGIFO, CONRADO EUGENIO. Cons. Engr. (Conrado E. Martinez y Rolando A. Martinez) Obispo No. 59 (Res., 27 No. 76 Vedado), Havana, Cuba	Assoc. M.	Oct. 7, 1908
	M.	Sept. 9, 1919
METCALFE, HARRY ARTUS. Roadmaster, A. G. S. R. R. (Southern Ry.), 1202 Second Ave., West End, Birmingham, Ala.		Sept. 9, 1919
MEYER, GROVER JOHN. Chf. Engr., Dept. of Railroads, Am. Radiator Co., 22 South Michigan Ave., Room 816, Chicago, Ill.	Assoc. M.	Oct. 29, 1912
	M.	June 16, 1919
MILLER, ALBERT ARTHUR. Dist. Engr., Western Dist., Mo. Pac. R. R., Room 627, Ry. Exchange Bldg., Kansas City, Mo.		June 16, 1919
MILLER, WALTER EDWARD. Div. Engr., Staff of R. R. Comm. of Wisconsin, Madison, Wis.	Assoc. M.	May 31, 1910
	M.	Sept. 9, 1919
MORROW, DAVID WILLIAM. 734 Garfield Bldg., Cleveland, Ohio		Sept. 9, 1919
MOSS, ROBERT EDWARD. Structural Engr., 126 Liberty St., New York City (Res., 88 Douglas Rd., Glen Ridge, N. J.)	Assoc. M.	May 2, 1900
	M.	Nov. 25, 1919

MEMBERS (*Continued*)

		Date of Membership.
OSBORNE, SIDNEY HOWARD. Div. Engr., U. P. R. R., Kansas City, Mo.		Sept. 9, 1919
OSGOOD, MANLEY. Engr., Detroit Bureau of Governmental Research, 100 Griswold St., Detroit, Mich.	Jun.	Dec. 31, 1913
	Assoc. M.	Dec. 6, 1915
	M.	Oct. 15, 1919
OWEN, ARTHUR EDMUND. Chf. Engr., U. S. Railroad Administration, P. & R. Ry., C. R. R. of N. J., 81 Grove St., Montclair, N. J.	Assoc. M.	May 3, 1905
	M.	Sept. 9, 1919
PEDEN, LEO THOMAS. Cons. Engr., 2204 Chartres St., Houston, Tex.	Assoc. M.	May 31, 1910
	M.	April 14, 1919
PERKINS, LOCKE MCINDOE. Corporate Engr., N. P. Ry., General Office, N. P. Ry., St. Paul, Minn.		Sept. 9, 1919
POPE, FRANCIS AMORY. Maj., Corps of Engrs., U. S. A., U. S. Engr. Bldg., Duluth, Minn.		Sept. 9, 1919
PORTER, JOHN ENDICOTT. Asst. Engr., Office of Engr. of Structures, N. Y. C. R. R., Grand Central Terminal, New York City (Res., 4 Ashburton Pl., Yonkers, N. Y.).	Jun.	Sept. 1, 1903
	Assoc. M.	May 2, 1911
	M.	Oct. 15, 1919
POWELL, WILLIAM JENNER. County Engr., Dallas County, Dallas, Tex.	Jun.	Jan. 2, 1906
	Assoc. M.	Sept. 3, 1913
	M.	Oct. 15, 1919
PRENTIS, EDMUND ASTLEY, JR. Engr. and Supt., Underpinning & Foundation Co., 408 West 23d St., New York City		Sept. 9, 1919
REITZ, HENRY GEORGE. City Engr., City Hall, West Park, Ohio.	Assoc. M.	June 3, 1915
	M.	Oct. 15, 1919
REQUARDT, GUSTAV JAEGER. Office Mgr., Norton, Bird & Whitman, 616 Munsey Bldg., Baltimore, Md.	Assoc. M.	Mar. 4, 1914
	M.	Nov. 25, 1919
RICH, MELVIN S. Cons. Structural Engr., 1410 H St., N. W., Washington, D. C.	Jun.	Sept. 5, 1905
	Assoc. M.	May 31, 1910
	M.	Sept. 9, 1919
RICHMOND, JULIAN. Gen. Mgr. Potdevin Machine Co., Brooklyn, N. Y.	Jun.	Feb. 2, 1904
	Assoc. M.	Dec. 4, 1907
	M.	Oct. 15, 1919
RICKETTS, ALLAN TOWNSHEND. Asst. Engr., Hill & Ferguson, 56 Chestnut St., Wyoming, N. J.		Sept. 9, 1919
RIEGEL, ROSS MILTON. Asst. Designing Engr., Miami Conservancy Dist., Dayton, Ohio.	Jun.	Mar. 5, 1907
	Assoc. M.	Feb. 28, 1911
	M.	Sept. 9, 1919
SAGE, WILLIAM HAMPDEN, JR. 411 Temple St., New Haven, Conn.		Sept. 9, 1919
SANDERSON, NATHAN HERBERT. Estimating Engr., Boston Bridge Works, Inc., 47 Winter St., Boston, Mass.	Assoc. M.	Feb. 1, 1905
	M.	Sept. 9, 1919

MEMBERS (*Continued*)

		Date of Membership.
SAUNDERS, GEORGE CROSBY. Asst. to Chf. Engr., Dietrich Bros., Pleasant and Davis Sts., Baltimore, Md.	Assoc. M. M.	Mar. 1, 1905 Nov. 25, 1919
SCHARFF, MAURICE ROOS. Asst. Chf. Engr. and Vice-Pres., Morris Knowles, Inc., 1200 Jones Bldg., Pittsburgh, Pa.	Jun. Assoc. M. M.	Feb. 6, 1912 Nov. 3, 1915 Sept. 9, 1919
SMITH, MAXWELL WAIDE. Dist. Sales Mgr., Duriron Castings Co., Dayton, Ohio.	Assoc. M. M.	April 17, 1917 Sept. 9, 1919
STEIN, MILTON FREDERICK. Asst. Engr., San. Dist. of Chicago, 6753 Lafayette Ave., Chicago, Ill.	Assoc. M. M.	Dec. 3, 1912 Sept. 9, 1919
STEVENSON, JAMES CUMMIN. Vice-Pres. and Acting Chf. Engr., H. L. Stevens Co., 30 North Michigan Ave., Chicago, Ill.	Assoc. M. M.	Mar. 4, 1913 Sept. 9, 1919
SULLIVAN, JOHN MARTIN. With Whitaker-Glessner Co., 5303 Kenmore Ave., Chicago, Ill.		Sept. 9, 1919
SUMNER, CHARLES RICHARD. Civ. Engr. and Surv. (Sumner & MacMillan); City Engr., Hermosa Beach, 318 H. W. Hellman Bldg., Los Angeles, Cal.		April 14, 1919
TAMMEN, HENRY CASPER. Asst. Engr., Harrington, Howard & Ash, 1012 Baltimore Ave., Kansas City, Mo.	Assoc. M. M.	Mar. 4, 1914 Oct. 15, 1919
TAYLOR, FREDERIC JACKSON. Dist. Engr., Central Dist., N. P. Ry., Box 537, Livingston, Mont.		Oct. 14, 1919
THOMAS, CHARLES DURA. Asst. Engr., Transit Constr. Comm., 70 East 45th St., New York City (Res., 201 Sterling Pl., Brooklyn, N. Y.)	Assoc. M. M.	Jan. 8, 1908 Oct. 15, 1919
TRASK, GEORGE FRANCIS DONNELL. Col., Q. M. C., U. S. A., Constr. Div., Cosmos Club, Washington, D. C.		Sept. 9, 1919
TRUSCOTT, STARR. Asst. for Lighter-than-Air, Bureau of Constr. and Repair (Aviation), Navy Dept., Washington, D. C.	Assoc. M. M.	May 31, 1916 Sept. 9, 1919
TUFEL, JOHN HENRY. Special Engr., Dept. of Public Utilities, City of Cleveland, 1526 East 85th St., Cleveland, Ohio		Sept. 9, 1919
VAN CLEVE, HORATIO PHILLIPS. Eng. Dept., J. Edward Ogden, 147 Cedar St., New York City (Res., 11 Burchfield Ave., Cranford, N. J.)		Sept. 9, 1919
VEST, JAMES MARSHALL. Pres. and Mgr. of Mines, Rum Creek Collieries & By-Product Co., 943 Twelfth Ave., Huntington, W. Va.		Oct. 14, 1919
VINNEDGE, GEORGE ESPY. Landscape Archt. and Civ. Engr., Route 2, Box 43A, Linnton, Ore.		Oct. 14, 1919
WASHINGTON, WALTER OWEN. (Whiteaker & Washington) Lockhart, Tex.	Assoc. M. M.	Feb. 6, 1912 Sept. 9, 1919

MEMBERS (*Continued*)

		Date of Membership.
Watson, George Linton. With Clyde Potts, 30 Church St., New York City (Res., 283 Parker St., Forest Hills, Newark, N. J.)	Assoc. M. M.	Jan. 15, 1917 Nov. 25, 1919
Weir, Robert John. Engr. in Chg., Seward Div., Alaskan Eng. Comm., Seward, Alaska		Sept. 9, 1919
White, Byron Ellsworth. Engr., Utica Gas & Elec. Co. (Res., 1019 Steuben St.), Utica, N. Y.	Jun. Assoc. M. M.	Oct. 2, 1906 July 1, 1908 May 12, 1919
Wig, Rudolph James. (Wig & Hollister). Widener Bldg., Philadelphia, Pa.	Assoc. M. M.	Sept. 12, 1916 Sept. 9, 1919
Wilbanks, John Robert. Cons. Engr., The R. L. Dollings Co., Columbus, Ohio.	Jun. Assoc. M. M.	June 4, 1907 Sept. 5, 1911 Oct. 15, 1919
Wilson, Everitt Wyche. 252 South French Broad Ave., Asheville, N. C.	Assoc. M. M.	Dec. 6, 1915 Oct. 15, 1919
Wood, Benjamin Russell. 1242 Taylor St., Apartment No. 6, San Francisco, Cal.	Assoc. M. M.	April 1, 1914 Sept. 9, 1919
Yager, Louis. Chf. M. of W. Engr., U. S. Railroad Administration, 614 Interstate Commerce Bldg., Washington, D. C.		Sept. 9, 1919

ASSOCIATE MEMBERS

Ash, William John. Civ. and Mech. Engr., Am. Cyanamid Co., 1462 Seventy-fifth St., Brooklyn, N. Y.		Nov. 25, 1919
Baker, Sylvester Clay. Engr., M. of W., East St. Louis & Suburban Ry., 603 North 14th St., East St. Louis, Ill.		Sept. 9, 1919
Bame, Robert William. Contr. Engr., McClintic-Marshall Co., 624 Union Central Bldg., Cincinnati, Ohio.		Sept. 9, 1919
Bartholomew, Harland. Engr. in Chg., City Plan Comm., 231 Municipal Courts Bldg., St. Louis, Mo.		Oct. 14, 1919
Belden, George Allyne. Asst. Engr., Dept., B. and B., Cent. of Ga. Ry., Savannah, Ga.	Jun. Assoc. M.	Oct. 29, 1912 Oct. 14, 1919
Bell, Harold Sill. Box 237, Elizabeth, N. J.		Oct. 14, 1919
Betaque, Harry Andrew. Lock Box 1413, San Diego, Cal.		Sept. 9, 1919
Bingham, Don William. With The James A. Welch Co., 111 West Kearsley St., Flint, Mich.		Sept. 9, 1919
Black, Joel Hoffman. Mgr., Constr. Dept., Standard Oil Co. of New York, Shanghai, China		Sept. 9, 1919
Bleistein, Bernard Joseph. Asst. Engr., Dept. of Water Supply, Gas and Electricity; Res., 240 Jamaica Ave., Long Island City, N. Y.	Jun. Assoc. M.	April 4, 1911 Oct. 14, 1919

ASSOCIATE MEMBERS (*Continued*)

	Date of Membership.
BLEY, CHARLES NICHOLAS. 2424 Prince St., Berkeley, Cal. ... Jun.	Nov. 12, 1913
... Assoc. M.	May 12, 1919
BOWMAN, JAMES SCHENCK. With Fargo Eng. Co., Jackson, Mich.	Oct. 14, 1919
BROCKMAN, GEORGE FRED. 1st Lieut., Engrs., U. S. A., 119 West St. Catherine, Louisville, Ky.	Sept. 9, 1919
BROWN, EARL DANIEL. 1750 Waller St., San Francisco, Cal. ... Jun.	Oct. 1, 1912
... Assoc. M.	Sept. 9, 1919
BUCHER, HENRY. Care, Robert M. Feustel, 331 Pearl St., Fort Wayne, Ind.	Sept. 9, 1919
BURDETTE, CHARLES ROLAND. 1534 Moreland Ave., Baltimore, Md.	Sept. 9, 1919
CARREL, WILLIAM JOSEPH. Prof. of Structural Eng., Univ. of Kentucky, Lexington, Ky.	Oct. 14, 1919
CASE, RAY NORMAN. 18 Tyler Ave., Ashtabula, Ohio.	Oct. 14, 1919
CHACE, THOMAS FRANKLIN. Chf. Structural Engr., Liberty Ship Yard, 2624 Piedmont Ave., Berkeley, Cal.	Sept. 9, 1919
CHAPMAN, VERNI JAY. Senior Civ. Engr., Bureau of Valuation, Interstate Commerce Comm., 601 Interstate Bldg., Kansas City, Mo.	April 14, 1919
CHILD, JOHN TOWNSHEND. With Bureau of Municipal Research, 501 Arlington Bldg., Rochester, N. Y. ... Jun.	Mar. 12, 1918
... Assoc. M.	Sept. 9, 1919
COCHRAN, ROBERT LEROY. Asst. State Engr., North Platte, Nebr.	Sept. 9, 1919
COCKROFT, EDGAR. Chf. Mech. Engr., Pacific Marine & Constr. Co., San Diego, Cal.	Mar. 11, 1919
COLLINS, EARL HARRY. Care, Michigan Northern Power Co., Sault Ste. Marie, Mich. . Jun.	Jan. 15, 1917
... Assoc. M.	Sept. 9, 1919
CONANT, LUTHER CHITTENDEN. Asst. Engr., C. R. R. of N. J., B. and B. Bldg., Allentown, Pa.	Oct. 14, 1919
CONRAD, HARRY LESTER. Constr. Engr., H. G. Christman Co., Olds Motor Works, Lansing, Mich. (Res., 731 Diamond Ave., South Bend, Ind.)	Oct. 14, 1919
COOKE, NORMAN HOMER. Civ. and Fire Protection Engr., Atlas Powder Co., 403 South Grant Ave., Wilmington, Del.	Nov. 25, 1919
COOMBES, JAMES LESLIE. Asst. Field Engr., U. S. Coal & Coke Co., Lynch Mines, Ky.	Sept. 9, 1919
COSBY, JOHN HAMILTON. With T. Coleman du Pont, 9 William St., Cambridge, Md.	May 12, 1919
COTTON, HARRY EDMOND. Office Engr., City Engr.'s Office, 512 City Hall, Omaha, Nebr.	Sept. 9, 1919
COULSON, HORACE WILKINSON. Capt., R. E., West Ville, Grosvenor Rd., South Shields, England.	Sept. 9, 1919

ASSOCIATE MEMBERS (*Continued*)

	Date of Membership.
COURTENAY, WILLIAM ALOYSIUS, JR. Archt. and Engr., 125 East 24th St., Chester, Pa.	Oct. 14, 1919
COX, DAVID JESSE. First Asst. City Engr. and Engr. in Chg. of Paving, Sewers, etc., 1126 East 7th St., Pueblo, Colo.	Oct. 14, 1919
CRAIG, ROBERT HALL. San. Engr. on Water Supply, Constr. Div. of the Army, Room 1-316, Bldg. C, Constr. Div., Washington, D. C.	Oct. 14, 1919
CRAIGMILE, CHARLES JAMES. With North Jersey Water Supply Comm., Midvale, N. J.	Oct. 14, 1919
CROSS, WILLIAM CLARENCE. Asst. Mech. Engr., Republic Ry. & Light Co., 60 Broadway, 19th Floor, New York City.	Nov. 25, 1919
DEANS, JOHN STERLING, JR. Gen. Supt., J. N. Byers & Son, Inc., 346 Linwood Ave., Buffalo, N. Y.	Sept. 9, 1919
DEMAREST, IRVING. Designing Engr., H. G. Balcom, 54 Garfield Ave., Madison, N. J.	Nov. 25, 1919
DOLAND, JAMES JOSEPH. 1000 Portland Ave., St. Paul, Minn.	Oct. 14, 1919
DOUGHER, WILLIAM EDWARD. 310 Beauregard St., Charleston, W. Va.	Oct. 14, 1919
DUBY, CLARENCE JOSEPH. 770 Cassius Ave., Youngstown, Ohio.	Nov. 25, 1919
DUERR, RAYMOND. Care, Am. Comm. for Relief in Near East, Bible House, Constantinople, Turkey	June 16, 1919
ECKELS, SAMUEL. Div. Engr., Bureau of Eng., City of Pittsburgh, 424 City-County Bldg., Pittsburgh, Pa.	Oct. 14, 1919
EDES, EDWARD LOUIS. Care, C. W. Randall, Grafton, Cal.	Sept. 9, 1919
EHRENBORG, GEORGE GEORGSSON. Field Engr., State Dept. of Public Roads, Dixon, Ky.	Sept. 9, 1919
ELTON, HERBERT CHARLES. Associated with A. H. Terry, 202 Maple St., New Haven, Conn.	Oct. 14, 1919
ERICKSON, DAVID LEONARD. 2729 Ryons St., Lincoln, Nebr.	Sept. 9, 1919
ERWIN, MARTIN CYRAL. Sewer Engr. and Prin. Asst. City Engr., 518 West Magnolia Ave., San Antonio, Tex.	Sept. 9, 1919
FERGUSSON, FRANK FAIRCHILD. Care, Boving & Co., 56 Kingsway, London, W. C. 2, England	Sept. 9, 1919
FINEBAUM, HARRY JACOB. Engr., Shipyard Plants Div., Emergency Fleet Corporation, Engineers' Club, 1317 Spruce St., Philadelphia, Pa.	Nov. 25, 1919
FISKE, ROBERT SEYMOUR. Sales Engr., Truscon Steel Co., 810 Commonwealth Bldg., Philadelphia, Pa.	Sept. 9, 1919
FITZGERALD, JAMES HENRY. 57 Pearsall Ave., Jersey City, N. J.	Sept. 9, 1919

ASSOCIATE MEMBERS (*Continued*)

	Date of Membership.
FOUHY, MICHAEL AUGUSTIN. Steel Expert, Emergency Fleet Corporation, 140 North Broad St., 9th Floor, Philadelphia, Pa	Sept. 9, 1919
FOX, EDWIN PHILIP. Designing Engr., McClintic-Marshall Constr. Co., 1217 Oliver Bldg., Pittsburgh, Pa	Sept. 9, 1919
FOX, ERNEST FRANZ, JR. 766 Westminster Rd., Brooklyn, N. Y	Sept. 9, 1919
GAGE, HOWARD ELMER. Gen. Supt. of Constr., United Erecting Co., 11712 St. Clair Ave., Suite No. 6, Cleveland, Ohio	Nov. 25, 1919
GERRISH, HERBERT THURSTON. Treas. and Mgr., Gerrish Dredging Co., 101 Tremont St., Boston, Mass	Oct. 14, 1919
GEUPEL, CARL MARTIN. Constr. Mgr., Thompson & Binger, Inc., 317 Gurney Bldg., Syracuse, N. Y	Oct. 14, 1919
GOCHNAUER, HARRY WALLIS. 814 Hippodrome Bldg., Cleveland, Ohio	Sept. 9, 1919
GOODALE, HARRY JOCELYN. Supt., Public Works, 27 Park St., Attleboro, Mass	Nov. 25, 1919
GOTTHEIM, IRVING. Contr. Engr., McClintic-Marshall Co., 520 Colman Bldg., Seattle, Wash	Sept. 9, 1919
GRAHAM, DALE JANVERIN. 313 East Clay St., Butler, Pa	Sept. 9, 1919
GRATHWOL, HENRY JACOB. Asst. Div. Engr., West Virginia State Road Comm., 901 Juliana St., Parkersburg, W. Va	Oct. 14, 1919
GRAY, EDWIN DWIGHT ALLEMAND. Highway Engr., Imperial Oil Co., Ltd., Toronto, Ont., Canada	Oct. 14, 1919
GREENOUGH, MAURICE BROWN. Secy., National Paving Brick Mfrs. Assoc., 830 Engineers Bldg., Cleveland, Ohio	Sept. 9, 1919
GREYDANUS, SYTZE ELO. Civ. and Mech. Engr., 112 Ellerson St., Paterson, N. J	Sept. 9, 1919
GUEVARA I MORALES, LUIS ALEJANDRE. Box 139, Trujillo, Peru	Sept. 9, 1919
HABICHT, GEORGE CONRAD. 1523 Quarrier St., Charleston, W. Va	Sept. 9, 1919
HALL, JOHN WENDELL. Res. Engr., Hugh L. Cooper, Mazeppa, Minn	Sept. 9, 1919
HALPERN, MICHAEL. Engr., Bayonne Terminal, The Texas Co., 169 Eleventh St., Long Island City, N. Y	Oct. 14, 1919
HANNUM, WILLIAM. Constr. Supt., The J. G. White Eng. Corporation, Christiana, Pa	Nov. 25, 1919
HARRISON, RANDOLPH. Care, Mees & Mees, Box 511, Albany, Ga.	May 12, 1919

ASSOCIATE MEMBERS (*Continued*)

		Date of Membership.
HARVIE, HENRY. Asst. to Hydr. Engr. of Design, Hydro-Elec. Power Comm. of Ontario, 190 University Ave., Toronto, Ont., Canada		May 12, 1919
HAUKE, CHARLES ROYCE. Cons. Engr.; County Engr., Blaine County, Chinook, Mont..	Jun.	Oct. 7, 1914
	Assoc. M.	April 14, 1919
HEFFELFINGER, JOHN MILTON, JR. Care, Div. of Eng. and Constr., Dept. of Public Service, City of Cleveland, City Hall, Room 618, Cleveland, Ohio	Jun.	June 23, 1916
	Assoc. M.	Nov. 25, 1919
HEISER, WILLIAM JOSEPH. Asst. Engr., Westinghouse, Church, Kerr & Co., 37 Wall St., New York City (Res., 458 Senator St., Brooklyn, N. Y.)	Jun.	Nov. 1, 1910
	Assoc. M.	Oct. 14, 1919
HESTERLY, HOMER WYNNE. Box 54, Tampa, Fla		Oct. 14, 1919
HIGGS, JAMES ALLAN, JR. Res. Mgr., Massey Concrete Products Corporation, 302 Candler Bldg., Atlanta, Ga.		Oct. 14, 1919
HOLBORN, LEWIS ADAMS. Asst. Engr., Seaboard A. L. R. R., 2204 Pearl St., Jacksonville, Fla	Jun.	Sept. 11, 1917
	Assoc. M.	May 12, 1919
HUTCHINS, ROLAND ELLIS. Designing Engr., Morgan Eng. Cos., 622 Goodwyn Inst. Bldg., Memphis, Tenn	Jun.	Nov. 1, 1910
	Assoc. M.	Jan. 14, 1918
JACKSON, WILLIAM. With Am. Bridge Co., 7417 Church Ave., Ben Avon, Pittsburgh, Pa		Nov. 25, 1919
JACOBSON, CARL JOSEPH. Vice-Pres., Farris Eng. Co., 1217 Empire Bldg., Pittsburgh, Pa		Sept. 9, 1919
JENNY, LOUIS ALFRED. Res. Engr., Emergency Fleet Corporation, Madison Ave., Dumont, N. J		Oct. 14, 1919
JESSUP, WALTER EDGAR. 1005 Brent Ave., South Pasadena, Cal	Jun.	April 1, 1914
	Assoc. M.	Sept. 9, 1919
JEWELL, JOHN LESTER. Secy. and Treas., Friestedt Underpinning Co., 746 St. Nicholas Ave., New York City		Nov. 25, 1919
KAHLERT, ERNEST DOUGLAS. Engr., E. I. du Pont de Nemours & Co., 420 South Sycamore St., Wilmington, Del		Sept. 9, 1919
KELLY, HARRY JOSEPH. Engr., Gulf Refining Co., 1637 Procter St., Port Arthur, Tex		Sept. 9, 1919
KINDRICK, ALPHA HARNEY. Care, T. P. Paxton, Commr. of Public Works, Okmulgee, Okla		Oct. 14, 1919
KING, WALTER JACOB. County Highway Engr., Labette County, Oswego, Kans		Oct. 14, 1919
KINNEAR, LAWRENCE WILSON. Mgr., Detroit Office, W. S. Kinnear & Co., 1272 Penobscot Bldg., Detroit, Mich	Jun.	Aug. 31, 1915
	Assoc. M.	Oct. 14, 1919
KNOX, ROBERT MAURICE. Gen. Supt. of Constr., Calumet Sag Channel, Box 58, Blue Island, Ill		Nov. 25, 1919

ASSOCIATE MEMBERS (*Continued*)

	Date of Membership.
KOCH, OSCAR HENRY. Cons. Engr. (Koch & Fowler), 606 Sumpter Bldg., Dallas, Tex	April 14, 1919
KUBITZ, FRITZ. Chf. Engr., Witherow Steel Co., 3 Arion St., Mt. Washington, Pittsurgh, Pa	Nov. 25, 1919
LANGE, WILLIAM HERBERT. 222 North Ave., New Rochelle, N. Y	Sept. 9, 1919
LATIMER, CLAUDE ALFRED. 425 West 160th St., New York City	Jun. Oct. 31, 1911 Assoc. M. Oct. 14, 1919
LEISTER, SIMON HAMMETT. Structural Engr. and Chf. Draftsman, The Austin Co., 1026 Bulletin Bldg., Philadelphia, Pa	Sept. 9, 1919
LENG, HORACE GREELEY. Asst. Engr., Dept. of Wharves, Docks, and Ferries, 616 Gaul St., Philadelphia, Pa	Sept. 9, 1919
LEVINE, LIONEL MONTEFIORE. Engr. in Chg., The J. H. Ladew Co., 530 Manhattan Ave., New York City	Oct. 14, 1919
LICHTENSTEIN, HARRY. 1102 Washington Ave., New York City	Jun. May 7, 1913 Assoc. M. May 12, 1919
LITTLE, JOHN GROVER. Eastern Eng. Editor, *Railway Age*, 2201 Woolworth Bldg., New York City	Sept. 9, 1919
LIVESAY, HENRY GAY. Asst. Engr., L. & N. R. R., Room 800, L. & N. Office Bldg., Louisville, Ky	Oct. 14, 1919
LIVINGSTON, HOMER BAILEY. Chf. Engr., Cameron Co., Water Imp. Dist. No. 2, Box 576, San Benito, Tex	Oct. 14, 1919
LONGWELL, JOHN STALKER. Asst. Engr., U. S. Reclamation Service, 509 Tramway Bldg., Denver, Colo	Jun. Oct. 3, 1911 Assoc. M. May 12, 1919
LOVERING, HARRY DOUGLAS. Structural Engr., Toltz, King & Day, Inc., St. Paul, Minn.	Jun. Sept. 2, 1914 Assoc. M. Oct. 14, 1919
LYON, WARREN ADAMS. Capt., Corps of Engrs., U. S. A., The Engr. School, Camp A. A. Humphreys, Va	Oct. 14, 1919
MCCASSY, STANLEY. Asst. Engr. of Bldgs., Ill. Cent. R. R., 135 East 11th Pl., Room 1000, Chicago, Ill	Jun. Nov. 4, 1914 Assoc. M. Oct. 14, 1919
MCLINTOCK, ADAM ARTHUR. Res. Civ. Engr., The Pacific Phosphate Co., Ltd., Ocean Island, Central Pacific, *via* Sydney, Australia	Sept. 9, 1919
MADDEN, CHARLES MICHAEL. Asst. Engr., Reservoir Dept., Board of Water Supply, New York City, Gilboa, N. Y.	Sept. 9, 1919
MANNES, ARTHUR SIVERINE. City Engr.; County Engr., Walworth, McPherson, and Harding Counties, Mobridge, S. Dak	Oct. 14, 1919
MELIN, OSCAR WILLIAM. Care, Structural Eng. Dept., Western Elec. Co., Hawthorne Station, Chicago, Ill	Jun. Dec. 3, 1913 Assoc. M. Oct. 14, 1919

ASSOCIATE MEMBERS (*Continued*)

		Date of Membership.
MERRILL, BERGEN STELLE. Structural Engr., Favrot & Livaudais, Ltd., 1204 Jackson Ave., New Orleans, La.		Oct. 14, 1919
MOCKLER, JOHN THOMAS. 335 Crescent Ave., Buffalo, N. Y.		Oct. 14, 1919
MOORE, JAMES GATES. Care, J. Henry Steinhart Co., Apartado 1070, Havana, Cuba		Oct. 14, 1919
MORELAND, ELDON WRIGHT. Efficiency Engr., Portland Ry., Light & Power Co., 505 Electric Bldg., Portland, Ore.		Sept. 9, 1919
MORGAN, THOMAS CHARLES. 1173 Bushwick Ave., Brooklyn, N. Y.	Jun.	May 15, 1917
	Assoc. M.	Oct. 14, 1919
MORRISON, ARTHUR HERBERT. With Aberthaw Constr. Co., 27 School St., Room 600, Boston, Mass.		June 16, 1919
MUNN, HARVEY TIMLOW. Civ. Engr., Eng. Dept., E. I. du Pont de Nemours Co., du Pont Bldg., Wilmington, Del.	Jun.	Dec. 31, 1913
	Assoc. M.	Oct. 14, 1919
NAGEL, HERBERT LINCOLN. 102 East Mill St., Akron, Ohio.		Sept. 9, 1919
NEIBERT, JAMES SHIVELY. Box 224, Greenwood, Ind.		May 15, 1917
NEWELL, HARRY EDMUND. Engr. in Chg. of War Dept., Bureau of Fire Prevention, and Advisory Engr. on Fire Prevention to Constr. Div. of the Army, 76 William St., New York City		Sept. 9, 1919
NEWMAN, ADELBERT JAMES. Box 562, Long Beach, Cal.		Oct. 14, 1919
NORDSTROM, EMIL AUGUST. Eng. Dept., 10-A, The B. F. Goodrich Co., Akron, Ohio		Oct. 14, 1919
ORLIAN, ISRAEL. Asst. Engr., Day & Zimmermann, Inc., 611 Chestnut St., Philadelphia, Pa		Sept. 9, 1919
OWEN, HARVEY SKIDMORE. Chf. Engr., Glencoe Lime & Cement Co., Syndicate Trust Bldg., St. Louis, Mo.		Sept. 9, 1919
OWEN, ROSCOE. Asst. Engr., Second Eng. Dist., Frisco R. R., 415 Frisco Bldg., Springfield, Mo.		Sept. 9, 1919
PEISER, FRED. Res. Engr., C. A. P. Turner Co., 30 Church St., New York City		April 14, 1919
PERRY, JOHN EDWIN. 503 Dryden Rd., Ithaca, N. Y.		Nov. 25, 1919
POST, ADOLPH JOSEPH. 428 Newberry St., Boston, Mass.	Jun.	May 6, 1914
	Assoc. M.	May 12, 1919
POWERS, LOUIS. Constr. Engr., Am. Gas & Elec. Co., Care, Ohio Power Co., 35 North 3d St., Newark, Ohio	Jun.	Sept. 5, 1911
	Assoc. M.	Nov. 25, 1919
PRIEST, HENRY MALCOLM. Research Engr., Airplane Eng. Dept., Bureau of Aircraft Production (Res., 221 Edgewood Ave.), Dayton, Ohio	Jun.	Nov. 12, 1913
	Assoc. M.	Sept. 9, 1919
PUGH, JOSEPH. Secy., Ely Constr. Co., 706 Lamar Bldg., Augusta, Ga.		Oct. 14, 1919
RAGSDALE, FRANK VICTOR. Constr. Engr., 634 Scimitar Bldg., Memphis, Tenn.		Oct. 14, 1919

ASSOCIATE MEMBERS (*Continued*)

	Date of Membership.
RANDOLPH, OTTO COFFEEN FITZ. Mgr., Railroad Dept., H. K. Ferguson Co., 6253 Euclid Ave., Cleveland, Ohio	Sept. 9, 1919
REAMS, CHATHAM COFFEE. Office Engr., Morgan Eng. Co., 622 Goodwyn Inst., Memphis, Tenn	Oct. 14, 1919
REDINGER, DAVID HUBBARD. Care, Southern California Edison Co., Kernville, Cal	Sept. 9, 1919
REYNOLDS, CHARLES HENRY. City Engr., 1615 Fifth Ave., West, Fort Dodge, Iowa	Nov. 25, 1919
RICE, CLIFTON. Richmond, Tex	June 16, 1919
ROBERTSON, GEORGE SADTLER. Prin. Asst. Engr. of Valuation, West, Md. Ry., 1628 Linden Ave., Baltimore, Md.	Sept. 9, 1919
ROBINSON, ERNEST LEFFERT. Turbine Eng. Dept., Gen. Elec. Co., Schenectady, N. Y	Sept. 9, 1919
ROBINSON, GEORGE NORMAN. Asst. Engr., Bureau of Streets and Highways, City of Newark, 50 Pennington St., Newark, N. J	Oct. 14, 1919
ROSS, BLAIR ARTHUR. Care, Novelty State Bank, Novelty, Mo. — Jun.	Mar. 13, 1917
— Assoc. M.	Oct. 14, 1919
ROULLARD, FELIX KING. Office Engr., C., M. & St. P. Ry., Room 3, Milwaukee Depot, Butte, Mont	Oct. 14, 1919
ROWE, DONALD HEFLEY. 380 East 14th St., North, Portland, Ore. — Jun.	May 7, 1913
— Assoc. M.	Oct. 14, 1919
RUBEY, HARRY KELLEY. Associate Prof. of Civ. Eng., Univ. of Washington, Seattle, Wash	Oct. 14, 1919
SACKETT, GUY WOODFORD. Civ. Engr., Atlantic, Gulf & Pacific Co., 381 Rutledge Ave., Charleston, S. C.	Oct. 14, 1919
SADLER, WALTER CLIFFORD. Eng. Dept., G. N. Ry., Seattle, Wash. — Jun.	Feb. 4, 1914
— Assoc. M.	Oct. 14, 1919
SAWDON, WALLACE ATTERBURY. City Engr., Laurel, Miss.	Nov. 25, 1919
SEALEY, DAVID ALFRED. Care, Truscon Steel Co. (Res., 617 Woodland Ave.), Youngstown, Ohio	Sept. 9, 1919
SIEMS, GEORGE HENRY. Engr.-Supt., State Experimental Honor System, Prison Labor, 1626 Quarrier Court, Charleston, W. Va	Oct. 14, 1919
SILVER, RALPH LAWRENCE. Basin, Wyo	Sept. 9, 1919
SIMONDS, FRED WASHBURN. City Mgr., Elizabeth City, N. C	Sept. 9, 1919
SMILLIE, RALPH. 50 Vanderbilt Ave., New York City — Jun.	Oct. 1, 1913
— Assoc. M.	Sept. 9, 1919
SMITH, BENJAMIN LE COMPTE. Asst. Engr., Norton, Bird & Whitman, 616 Munsey Bldg., Baltimore, Md	Sept. 9, 1919
SMITH, HERSCHEL C. Asst. Engr., State Engr.'s Office, Oklahoma, Okla. — Jun.	April 18, 1916
— Assoc. M.	Oct. 14, 1919
SMITH, HILMAR FREDERICK. 614 Wood Ave., Florence, Ala.	Nov. 25, 1919

ASSOCIATE MEMBERS (*Continued*)

	Date of Membership.
SMITH, JULIAN POLK. 316 Summit Ave., Graymont Heights, Birmingham, Ala.	Oct. 14, 1919
SMITH, STANLEY. Engr., Designing Section, Shipyard Plants Div., Emergency Fleet Corporation, 5662 Hadfield St., Philadelphia, Pa.	Nov. 25, 1919
SPEED, WILLIAM. Cons. Engr., 1634 Beechwood Ave., Louisville, Ky.	Nov. 25, 1919
STAUFFEN, FREDERICK CHARLES. Plant Engr., Union Shipbuilding Co., Box 475 (Res., 3614 Greenmount Ave.), Baltimore, Md.	Oct. 14, 1919
STAUFFER, ISAAC YOST. Care, Standard Oil Co. of New York, Batavia, Java.	Jun. May 31, 1916 Assoc. M. May 12, 1919
STEINBRUCH, WALTER. Asst. Supt., The Austin Co., 1026 Bulletin Bldg., Philadelphia, Pa. (Res., 406 Westminster Rd., Brooklyn, N. Y.)	Jun. May 6, 1914 Assoc. M. Sept. 9, 1919
STEVENS, LEONARD JACKSON. Vice-Pres., H. L. Stevens & Co., 30 North Michigan Ave., Chicago, Ill.	Oct. 14, 1919
STEWART, WILLIAM HENRY. Gen. Supt., Central Indiana Coal Co., Dugger, Ind.	Oct. 14, 1919
STUPP, JOHN GEORGE. Designing Engr., Stupp Bros. Bridge & Iron Co., 4053 De Tonty St., St. Louis, Mo.	Jun. April 30, 1912 Assoc. M. Oct. 14, 1919
SWOPE, ERNEST ELBA. Chf. Engr., Magnolia Petroleum Co., Beaumont, Tex.	June 16, 1919
TAYLOR, ORVILLE HEBER. Asst. Engr., C., M & St. P. Ry., 6939 Dorchester Ave., Chicago, Ill.	Sept. 9, 1919
TCHIKOFF, VALENTINE VASILIEVICH. Cons. Engr., 165 West 83d St., New York City.	Sept. 9, 1919
TOBY, MAURICE. Engr., New York & Queens County Ry., 190 Nagle Ave., New York City.	Nov. 25, 1919
TOWNSEND, DARWIN WADSWORTH. Engr. of Design, Sewerage Comm., City of Milwaukee, City Hall, Milwaukee, Wis.	Nov. 25, 1919
TRIMBLE, EARLE JAMES. Clifton Springs, N. Y.	Oct. 14, 1919
VAUGHAN, HENRY FRIEZE. Commr., Dept. of Health, City of Detroit, Detroit, Mich.	Oct. 10, 1916 Assoc. M. Sept. 9, 1919
VON ZUBEN, FRANCIS JOSEPH. City Engr., 1115 South Lake St., Fort Worth, Tex.	Sept. 9, 1919
WACHTER, RICHARD EMIL. Asst. Engr., Mo. Pac. R. R., 1085 Railway Exchange Bldg., St. Louis, Mo.	Sept. 9, 1919
WADHAMS, MOSES ALLYN. 197 Adelaide St., Hartford, Conn.	Oct. 14, 1919
WAGEN, JACOB CHARLES. Chf. Engr., The Lake Worth Drainage Dist., Lake Worth, Fla.	Sept. 9, 1919

ASSOCIATE MEMBERS (*Continued*)

	Date of Membership.
WALKER, PHILIP BANGS. 91 Bradford St., Needham, Mass.	Oct. 14, 1919
WALKER, ROY OLLIN. 4052 North Keystone Ave., Chicago, Ill.	June 16, 1919
WARING, FREDERICK HOLMAN. Asst. San. Engr., Ohio State Dept. of Health, Columbus, Ohio.	Jun. May 7, 1913 Assoc. M. Sept. 9, 1919
WARKLEY, JOHN CROSWELL. Constr. Engr., Midwest Refining Co., Casper, Wyo.	Jun. Dec. 3, 1912 Assoc. M. Oct. 14, 1919
WEBB, HOWARD WILLIAM. Railroad Engr., Submarine Boat Corporation, 235 Fairmount Ave., Newark, N. J.	April 14, 1919
WEINER, RUDOLPH SIGMUND. Mgr., Sullivan Masley Co., 511 Mills Bldg., El Paso, Tex.	May 12, 1919
WHITNEY, CHARLES EARL. Maj., Ord., U. S. A., Boston Dist. Ordnance Office, 19 Portland St., Boston, Mass.	Oct. 14, 1919
WILDER, HENRY LINCOLN. Supt., Pennsylvania State Highway Dept., 823 Church St., Lebanon, Pa.	Sept. 9, 1919
WILLIAMSON, LEE HOOMES. Care, The Texas Co., Edificio Silva, San Juan, Porto Rico.	Jun. Oct. 9, 1917 Assoc. M. Oct. 14, 1919
WILSON, EMMET CHEATHAM. Structural Engr., Tennessee Coal, Iron & R. R. Co., Birmingham, Ala.	Jun. Aug. 31, 1915 Assoc. M. May 12, 1919
WILSON, FRANCIS DOUGLAS. 282 Park View Ave., Detroit, Mich.	Sept. 9, 1919
WILSON, WILLIAM HENRY. Asst. Engr., South. R. R., 411 Henson Bldg., Knoxville, Tenn.	Nov. 25, 1919
WOOD, CARL WILBUR. Asst. Constr. Engr., Stone & Webster, 147 Milk St., Boston (Res., 39 Greenleaf St., Malden), Mass.	Sept. 9, 1919
WOOD, EUGENE NORTH. Cons. Engr. (Wood, Elton & Witten), 209 Lynch Bldg., Tulsa, Okla.	Oct. 14, 1919
WYNN, ALBERT EDWARD. Engr., Thompson & Binger, Inc., Gurney Bldg., Syracuse, N. Y.	Sept. 9, 1919
WYNNE, HAROLD GEORGE. 1596 Boulevard, New Haven, Conn.	Sept. 9, 1919
ZIMMER, JUDSON. Master Mechanic and Chf. Engr., Fonda, Johnstown & Gloversville R. R., Gloversville, N. Y.	April 14, 1919

ASSOCIATES

CRITCHER, ALAN HAWES. Care, United States Shipping Board, Emergency Fleet Corporation, 380 Eddy St., San Francisco, Cal.	Oct. 14, 1919
DEWEY, CLARENCE LENNON. Pres., Dewey Cement Gun Constr. Co., and Pres., Traylor-Dewey Contr. Co., Traylor Hotel, Allentown, Pa.	Nov. 25, 1919

ASSOCIATES (*Continued*)

	Date of Membership.
RHODES, ALBERT TAYLOR. Dist. Engr., The Asphalt Assoc., Builders Exchange, Worcester, Mass	Sept. 9, 1919
SIMMONS, EDWARD ALFRED. 1625 Ditmas Ave., Brooklyn, N. Y	Oct. 14, 1919

JUNIORS

ANDERSON, BJARNE BERGSLAND. 4509 Sixth Ave., Brooklyn, N. Y	Oct. 14, 1919
ARNOLD, FRANK PALMER. Asst. Engr., West Virginia State Road Comm., 43 California Pl., Charleston, W. Va.	Sept. 9, 1919
BALLEISEN, LEOPOLD LYON. Engr., Hazen, Whipple & Fuller; Res., 409 Ave. C, Brooklyn, N. Y	Sept. 9, 1919
BOHANNON, JOHN NEIL. County and Project Engr., Washington County, Sandersville, Ga	Oct. 14, 1919
BOWER, ANDREW THOMAS. Estimating Engr., Am. International Shipbuilding Corporation, 3232 Chestnut St., Philadelphia, Pa	Oct. 14, 1919
BUCK, GEORGE HERMAN. Chf. of Party, Ford, Bacon & Davis, South Clinchfield, Va	Oct. 14, 1919
CLEARY, JOHN BELFORD. Office Engr., Midwest Refining Co., Box 562, Casper, Wyo	Sept. 9, 1919
CONSTANT, CLYDE STANLEY. Supt., The Kaw Paving Co., Topeka (Res., 743 Rhode Island St., Lawrence), Kans.	Oct. 14, 1919
CORMAN, WILLIAM. Structural Engr., Gabriel Steel Co., Detroit, Mich	Oct 14, 1919
COWLES, MARTIN WARREN. Analyst, Dept. of Public Health, Springfield, Ill	April 14, 1919
COX, WILLIAM JUNKIN. Box 86, Big Stone Gap, Va	Sept. 9, 1919
CRISTAL, PHILIP NAHM. Capt., Corps of Engrs., U. S. A., Engr. School, Camp A. A. Humphreys, Va	Oct. 14, 1919
CRITZAS, EVANGELOS JOHN. 581 West 161st St., New York City	Sept. 9, 1919
DAY, WILLARD FARNSWORTH. County Engr., Campbell County, 41 Medical Bldg., Lynchburg, Va	Sept. 9, 1919
EBERHARD, ARTHUR CHARLES. Lieut., C. E. C., U. S. N., Lafayette Radio Station, Croix d'Hins, France	Sept. 9, 1919
GAMSU, FREDERICK CONRAD. Eng. Draftsman, Submarine Boat Corporation, 854 West 180th St., New York City	June 16, 1919
HASTIE, FRANK BOWMAN. Capt., Corps of Engrs., U. S. A., Engr. School, Camp A. A. Humphreys, Va	Oct. 14, 1919
HECHMER, CARL ADAM. Dept. Engr., Washington Suburban San. Dist., Hyattsville, Md	Oct. 14, 1919

JUNIORS (*Continued*)

	Date of Membership.
HUTTON, HAROLD STEPHENS. Scientific Asst., U. S. Public Health Service, Perryville, Md	Nov. 25, 1919
JONES, CHARLES WEST. Care, California Highway Comm., Sacramento, Cal	Sept. 9, 1919
KUPEC, WILLIAM JOSEPH. Draftsman, Fougner Concrete Steel Co., Inc., 29 Broadway, New York City	Sept. 9, 1919
MCKINSTRY, ROSS WALDRON. 5131 Kimbark Ave., Chicago, Ill	Oct. 14, 1919
MORRELL, RALPH LEONARD. 4200 Wilcox St., Chicago, Ill	Nov. 25, 1919
NEINKEN, MORTIMER LOUIS. 1472 Fifty-sixth St., Brooklyn, N. Y	Oct. 9, 1917
OKUBO, TOSHIYUKI. Care, Waddell & Son, 35 Nassau St., New York City	Sept. 9, 1919
PERRY, AUBREY EUGENE. Watermaster, Dist. No. 5, State of Oregon, and County Surv., Umatilla County, Box 593, Pendleton, Ore	Sept. 9, 1919
PIERCE, LESLIE EDWARD. 2d Lieut., A. S. (A.), U. S. A., McCook Field, Dayton, Ohio	Oct. 14, 1919
PLUM, SVEND MUNK. Eng. Dept., Truscon Steel Co., Youngstown, Ohio	Oct. 14, 1919
SEAMAN, WILLIAM LAURIE. (William H. Seaman), Box 466, Glen Cove, N. Y	Oct. 14, 1919
SEYMOUR, EDWIN NEWBURGER. Care, Southern Eng. Co., Clarksdale, Miss	June 16, 1919
SHUPE, ELMER BYRON. Instrumentman, Pennsylvania State Highway Comm., R. D. No. 2, Box 57, Allison Park, Pa	Oct. 14, 1919
SMITH, RALPH ADAMS. Draftsman, Turners Falls Power & Elec. Co., 38 Central St., Turners Falls, Mass	Nov. 25, 1919
TARTT, PHILLIPS BRANCH. 506 West Moore Ave., Terrell, Tex	Sept. 9, 1919
THOMPSON, SAMUEL HYDE. Plant Insp., Oregon State Highway Dept., Gold Hill, Ore	Oct. 14, 1919
TIETZEL, ALBERT MICHAEL. Designer, Cambria Steel Co., 17 Irene St., Johnstown, Pa	Mar. 11, 1919
TIMMERMAN, WAYNE EDWARD. Civ. Engr., Pine Grove Realty Co., Massena, N. Y	Oct. 14, 1919
TWITTY, JOSEPH JONES. 2d Lieut., Corps of Engrs., U. S. A., Camp A. A. Humphreys, Va	Oct. 14, 1919
VAN DYKE, CHARLES WILLIAM. Engr., Technical Dept., Atlas Portland Cement Co., 30 Broad St., New York City	Sept. 9, 1919
VOSKA, ANTHONY GEORGE. Head Draftsman, Ash Grove L. & P. C. Co., 401 North Forest Ave., Chanute, Kans.	Oct. 14, 1919

JUNIORS (*Continued*)

	Date of Membership.
WALSH, MALCOLM. With Walsh & Wertheim, New Brighton, N. Y.	Oct. 14, 1919
YORK, ROBERT EVERETT. 2d Lieut., Corps of Engrs., U. S. A.; 133 West 11th St., New York City	Nov. 25, 1919

REINSTATEMENTS

MEMBERS

	Date of Reinstatement.
MILLER, FRANK	October 14, 1919

RESIGNATIONS

MEMBERS

	Date of Resignation.
GARRETT, JAMES EDWIN	October 14, 1919

ASSOCIATE MEMBERS

ANGEL, FLOYD DWIGHT	October 14, 1919
LUDWIG, JULIUS ALFRED	October 14, 1919

ASSOCIATES

SMITH, ROBERT ALEXANDER CHIQUENO	October 14, 1919

JUNIORS

MACKAY, CHARLES WALKER	October 14, 1919
WHITNEY, RALPH EDWARD	October 14, 1919

DEATHS

ASHMEAD, PERCY HERBERT. Elected Member, March 6th, 1907; died November 11th, 1919.

CHURCH, CHARLES TITUS. Elected Member, May 1st, 1889; died August 25th, 1919.

DAVIS, CHESTER BIRGE. Elected Member, February 1st, 1882; died September 16th, 1919.

FREW, ARCHIBALD SMITH. Elected Member, October 3d, 1900; date of death unknown.

GRAVES, WALTER HAYDEN. Elected Member, February 2d, 1909; died September 26th, 1919.

HAZEN, JOHN VOSE. Elected Associate, June 5th, 1889; Member, May 2d, 1911; died October 2d, 1919.

JACOBS, CHARLES MATTATHIAS. Elected Member, May 4th, 1904; died September 7th, 1919.

JAYCOX, THOMAS WILLIAM. Elected Member, January 4th, 1882; died September 8th, 1919.

MANLEY, HENRY. Elected Member, June 2d, 1880; died October 28th, 1919.

MILLS, GEORGE CLARK. Elected Member, June 4th, 1913; died August 13th, 1919.

REDLICH, CARL. Elected Member, September 7th, 1904; date of death unknown.

WILSON, HUGH MONROE. Elected Associate, December 3d, 1913; died September 19th, 1919.

WOOD, IRVING SPARROW. Elected Junior, March 5th, 1890; Associate Member, March 7th, 1900; Member, March 6th, 1906; died October 20th, 1919.

Total Membership of the Society, December 3d, 1919, 9 415.

MONTHLY LIST OF RECENT ENGINEERING ARTICLES OF INTEREST

(September 1st to November 22d, 1919)

NOTE.—*This list is published for the purpose of placing before the members of this Society, the titles of current engineering articles, which can be referred to in any available engineering library, or can be procured by addressing the publication directly, the address and price being given wherever possible.*

LIST OF PUBLICATIONS

In the subjoined list of articles, references are given by the number prefixed to each journal in this list:

(2) *Journal,* Engrs. Club of Phila., Philadelphia, Pa.
(3) *Journal,* Franklin Inst., Philadelphia, Pa., 50c.
(4) *Journal,* Western Soc. of Engrs., Chicago, Ill., 50c.
(5) *Journal,* Eng. Inst. of Canada, Montreal, Que., Canada.
(6) *Journal,* Am. Inst. of Archts., Washington, D. C., 50c.
(7) *Gesundheits Ingenieur,* Munich, Germany.
(8) *Stevens Indicator,* Hoboken, N. J., 50c.
(9) *Industrial Management,* New York City, 25c.
(11) *Engineering* (London), W. H. Wiley, 432 Fourth Ave., New York City, 25c.
(12) *The Engineer* (London), International News Co., New York City, 35c.
(13) *Engineering News-Record,* New York City, 15c.
(15) *Railway Age,* New York City, 15c.
(16) *Engineering and Mining Journal,* New York City, 15c.
(17) *Electric Railway Journal,* New York City, 10c.
(18) *Railway Review,* Chicago, Ill., 15c.
(19) *Scientific American Supplement,* New York City, 10c.
(20) *Iron Age,* New York City, 20c.
(21) *Railway Engineer,* London, England, 1s. 2d.
(22) *Iron and Coal Trades Review,* London, England, 6d.
(24) *American Gas Engineering Journal,* New York City, 10c.
(25) *Railway Mechanical Engineer,* New York City, 20c.
(26) *Electrical Review,* London, England, 4d.
(27) *Electrical World,* New York City, 10c.
(28) *Journal,* New England Water-Works Assoc., Boston, Mass., $1.
(29) *Journal,* Royal Soc. of Arts, London, England, 6d.
(32) *Mémoires et Compte Rendu des Travaux,* Soc. Ing. Civ. de France, Paris, France.
(33) *Le Génie Civil,* Paris, France, 1 fr.
(36) *Cornell Civil Engineer,* Ithaca, N. Y.
(40) *Zentralblatt der Bauverwaltung,* Berlin, Germany, 60 pfg.
(41) *Elektrotechnische Zeitschrift,* Berlin, Germany.
(42) *Proceedings,* Am. Inst. Elec. Engrs., New York City, $1.
(43) *Annales des Ponts et Chaussées,* Paris, France.
(45) *Coal Age,* New York City, 15c.
(46) *Scientific American,* New York City, 15c.
(47) *Mechanical Engineer,* Manchester, England, 3d.
(48) *Zeitschrift,* Verein Deutscher Ingenieure, Berlin, Germany, 1, 60 m.
(49) *Zeitschrift für Bauwesen,* Berlin, Germany.
(50) *Stahl und Eisen,* Düsseldorf, Germany.
(53) *Zeitschrift,* Oesterreichischer Ingenieur und Architekten-Verein, Vienna, Austria, 70h.
(54) *Transactions,* Am. Soc. C. E., New York City, $16.
(55) *Mechanical Engineering:* Journal, Am. Soc. M. E., New York City, 35c.
(56) *Transactions,* Am. Inst. Min. and Metallurgical Engrs., New York City, $6.
(57) *Colliery Guardian,* London, England, 5d.
(58) *Proceedings,* Engrs.' Soc. of W. Pa., 2511 Oliver Bldg., Pittsburgh, Pa., 50c.
(59) *Proceedings,* American Water Works Assoc., Troy, N. Y.
(60) *Municipal and County Engineering,* Indianapolis, Ind., 25c.
(61) *Proceedings,* Western Railway Club, 225 Dearborn St., Chicago, Ill., 25c.
(62) *American Drop Forger,* Thaw Bldg., Pittsburgh, Pa., 10c.
(63) *Minutes of Proceedings,* Inst. C. E., London, England.
(64) *Power,* New York City, 10c.
(65) *Official Proceedings,* New York Railroad Club, Brooklyn, N. Y., 15c.
(66) *Gas Journal,* London, England, 6d.
(67) *Cement and Engineering News,* Chicago, Ill., 25c.
(69) *Eisenbau,* Leipzig, Germany.
(71) *Journal,* Iron and Steel Inst., London, England.
(71a) *Carnegie Scholarship Memoirs,* Iron and Steel Inst., London, England.

(72) *American Machinist,* New York City, 15c.
(73) *Electrician,* London, England, 18c.
(75) *Proceedings,* Inst. of Mech. Engrs., London, England.
(77) *Journal,* Inst. Elec. Engrs., London, England, 5s.
(78) *Beton und Eisen,* Vienna, Austria, 1, 50m.
(80) *Tonindustrie Zeitung,* Berlin, Germany.
(83) *Gas Age,* New York City, 15c.
(85) *Proceedings,* Am. Ry. Eng. Assoc., Chicago, Ill.
(86) *Engineering and Contracting,* Chicago, Ill., 10c.
(87) *Railway Maintenance Engineer,* Chicago, Ill., 10c.
(89) *Proceedings,* Am. Soc. for Testing Materials, Philadelphia, Pa., $5.
(90) *Transactions,* Inst. of Naval Archts., London, England.
(91) *Transactions,* Soc. of Naval Archts. and Marine Engrs., New York City.
(92) *Bulletin,* Soc. d'Encouragement pour l'Industrie Nationale, Paris, France.
(93) *Revue de Métallurgie,* Paris, France, 4 fr. 50.
(96) *Canadian Engineer,* Toronto, Ont., Canada, 10c.
(98) *Journal,* Engrs. Soc. of Pa., Harrisburg, Pa., 30c.
(99) *Proceedings,* Am. Soc. of Municipal Improvements, New York City, $2.
(100) *Professional Memoirs,* Corps of Engrs., U. S. A., Washington, D. C., 50c.
(103) *Mining and Scientific Press,* San Francisco, Cal., 10c.
(104) *The Surveyor and Municipal and County Engineer,* London, England, 6d.
(105) *Chemical and Metallurgical Engineering,* New York City, 25c.
(106) *Transactions,* Inst. of Min. Engrs., London, England, 6s.
(107) *Schweizerische Bauzeitung,* Zürich, Switzerland.
(109) *Journal,* Boston Soc. C. E., Boston, Mass., 50c.
(110) *Journal,* Am. Concrete Inst., Philadelphia, Pa., 50c.
(111) *Journal of Electricity,* San Francisco, Cal., 25c.
(113) *Proceedings,* Am. Wood Preservers' Assoc., Baltimore, Md.
(114) *Journal,* Institution of Municipal and County Engineers, London, England, 1s. 6d.
(115) *Journal,* Engrs.' Club of St. Louis, St. Louis, Mo., 35c.
(116) *Blast Furnace and Steel Plant,* Pittsburgh, Pa., 15c.
(117) *Engineering World,* Chicago, Ill.
(118) *Times Engineering Supplement,* London, England, 2d.
(119) *Landscape Architecture,* Harrisburg, Pa., 50c.
(120) *Automotive Industries,* New York City, 15c.

LIST OF ARTICLES

Bridges.

A Problem on the Hydraulic Resistance of a Bridge Over the Chemung River at Elmira, N. Y. S. C. George and E. W. Rettger. (36) May.
Rebuilding an Old Masonry Arch Bridge. (86) Aug. 27.
Method of Rebuilding the Genesee River Bridge, Lehigh Valley R. R. (86) Aug. 27.
Viaduct Protected from Snowslides by Concrete Walls.* E. E. Adams. (13) Sept. 4.
Subway Lighting for New Cleveland Bridge.* Ward Harrison and Earl A. Anderson. (27) Sept. 6.
Concrete Ties Hold Together Walls of Bridge-Approach Fill.* (13) Sept. 11.
War-Time Economies in Strengthening Old Bridges.* E. E. Howard. (15) Sept. 12.
Highway Bridge Floor Replaced after Corrosion. (13) Sept. 18.
Steel-Plate Drip Floor for Niagara Railway Arch.* (13) Sept. 25.
Headgates Combined with Bridge Over Aqueduct Canal.* (13) Sept. 25.
Portable Military Bridges.* C. E. Inglis. (Paper read before British Assoc.) (12) Serial beginning Sept. 26.
Bridging the Rhine with German Pontoon Equipage.* S. C. Godfrey. (100) Sept.–Oct.
Strengthening Old Bridges in War Time.* E. E. Howard. (87) Oct.
Practices in Pile Driving Vary Widely.* (87) Oct.
English Channel Train Ferry Bridge of 120-Ft. Span.* P. J. Risdon. (13) Oct. 2.
Unusual Design and Joint Details of 430-Ft. Bridge. (13) Oct. 2.
Bridge Engineering in Active Warfare.* Lewis E. Moore and Marshall W. McDonald. (13) Serial beginning Oct. 9.
Heavy Double Trestle for Shipbuilding Cranes Over Newport News Battle-Cruiser Berths.* R. W. Burpee. (13) Oct. 16.
Heavy Steel Highway Bridging at the Front.* A. C. Oxley. (96) Oct. 16.
Load Concentrations on Steel Floor Joists of Wood Floor Highway Bridges.* (From *Bulletin* issued by Iowa State College of Agriculture and Mechanic Arts.) (86) Oct. 22.
A Field Bloudin Ropeway as an Aid to Bridge Erection.* I. Simson. (From Royal Engineers' *Journal.*) (86) Oct. 29.
Report on Methods and Equipment Used in Renewing Timber Bridges in Whole and in Part. (Am. Ry. Bridge and Bldg. Assoc.) (87) Nov.

* Illustrated.

Bridges—(Continued).

Methods and Equipment Used in Renewing Timber Bridges. (From report of Committee, Am. Ry. Bridge and Bldg. Assoc.) (**18**) Nov. 1.
Big Bascule Bridge Over the Chicago River.* (**18**) Nov. 15.
Ueber den Umbau und die Verstärkung der eisernen Brücken auf der Bergstrecke Erstfeld-Bellinzona der Gotthardlinie.* A. Bühler. (**107**) Aug. 9.
Wettbewerb für die Rötibrücke in Solothurn.* (**107**) Sept. 20.

Electrical.

Electromagnetic Theory of the Telephone Receiver.* A. E. Kennelly and H. Nukiyama. (**42**) Apr.
Large Batteries for Power Purposes.* E. C. McKinnon. (**77**) July.
Pulsation of the D. C. Terminal Voltage in Rotary Converters.* J. K. Kostko. (**73**) Serial beginning July 11.
Large Power Transformers.* A. G. Ellis and J. L. Thompson. (**77**) Aug.
Magnetic Storms.* C. Chree. (**77**) Aug.
A Seaplane Wireless Transmitting Set.* (From the *T. and T. Age.*) (**26**) Aug. 22.
Electrification of a Three-High Merchant Mill.* (**26**) Aug. 22.
Electric Machinery Control.* (**11**) Aug. 29.
Automatic Isolation of Faults on High-Tension A. C. System.* (Paper read before Assoc. of Min. Elec. Engrs.) (**22**) Aug. 29.
Balancing and Alignment of the Alternator Rotor.* C. Sylvester. (**26**) Aug. 29.
The Magnetic Field Round a Submerged Cable Carrying Alternating Current.* H. R. Rivers-Moore. (**26**) Aug. 29.
A Simple Derivation of the Formulas for the Resonance Curves of a Damped Vibration and Some Properties Thereof.* Balth. Van Der Pol. (**73**) Serial beginning Aug. 29.
Inherent Limitations on Transformations Possible by Stationary Apparatus.* Joseph Slepian. (**42**) Sept.
California 220 000-Volt—1 100-Mile—1 500 000-Kw. Transmission Bus.* R. W. Sorensen and others. (**42**) Sept.
Some New Formulas for Reactance Coils.* H. B. Dwight. (**42**) Sept.
Theory and Practical Attainments in the Design and Use of Radio Direction Finding Apparatus Using Closed Coil Antennas.* A. S. Blatterman. (**3**) Sept.
Cracking of Pin Type Corner Porcelain Insulators. S. L. Foster. (**111**) Sept. 1.
The Rotating Magnetic Field in Alternating Current Motors.* F. A. Annett. (**64**) Sept. 2.
What is the Synchronous Motor?* Will Brown. (**64**) Sept. 2.
Thermophones or Hot-Wire Receivers.* (**73**) Sept. 5.
A Heterodyning Wavemeter.* J. Scott-Taggart. (**73**) Sept. 5.
Subway Lighting for New Cleveland Bridge.* Ward Harrison and Earl A. Anderson. (**27**) Sept. 6.
Study of Unbalanced Three-Phase Loads.* Leonard Allison Doggett. (**27**) Sept. 6.
Europe Power Plant Practice.* Stephen Q. Hayes. (**27**) Serial beginning Sept. 6.
An Electrostatic Direction Finder.* E. Bellini. (**73**) Sept. 12.
The Measurement of Alternating Waves with the Braun Tube.* E. Lübke. (From *Archiv. für Electrotechnik.*) (**73**) Sept. 12.
Rectifying High-Tension Alternating Currents.* Samuel Cohen. (**27**) Sept. 13.
Merz-Price Protection for Alternators and Transformers.* C. W. Marshall. (**26**) Sept. 12.
Locating Defective Transmission-Line Insulators.* T. F. Johnson, Jr. (**27**) Sept. 13.
Synchronous Condensers in High-Tension System.* J. W. Andree. (**27**) Sept. 13.
The Nisqually Substation at Tacoma, Washington.* (**111**) Sept. 15.
Modern Mine-Wiring Practice.* Terrell Croft. (**45**) Sept. 18.
Converting Machines to Individual Drive.* (**27**) Sept. 20.
The Synchronous Motor in Operation.* Will Brown. (**64**) Sept. 23.
The Principle of Relativity Simply Explained.* R. W. Western. (**26**) Serial beginning Sept. 26.
The Electrical Driving of Rolling Mills.* A. P. Pyne. (**73**) Sept. 26.
Electrical Practice in the Equipment of Blast Furnace Plant.* J. Percy Hodges. (**73**) Sept. 26.
The Electric Control of Steel Mill Auxiliaries.* C. Howard (**73**) Sept. 26.
Developments in Lifting Magnet Practice.* F. N. Pickett. (**73**) Sept. 26.
Overhead Electric Cranes in Steelworks.* James Smith. (**73**) Sept. 26.
Constructing a Line Under Difficulties.* Carl L. Raymond. (**27**) Sept. 27.
Motors for Rolling Mill Table Drives.* W. S. Hall. (Paper read before Assoc. of Iron and Steel Elec. Engrs.) (**116**) Oct.
Preventing Overloads on Steel Mill Motors.* P. M. Lincoln. (Paper read before Assoc. of Iron and Steel Elec. Engrs.) (**116**) Oct.
Protecting Mill Cranes from Overload. A. G. Place. (Paper read before Assoc. of Iron and Steel Elec. Engrs.) (**116**) Oct.

* Illustrated.

Electrical—(Continued).

The Vacuum Tube as a Generator of Alternating-Current Power.* John H. Morecroft and H. Trap Friis. (42) Oct.
The Positions of Atoms in Metals.* A. W. Hull. (42) Oct.
A Report on Electromagnetic Induction.* S. J. Barnett. (42) Oct.
Principles of Radio Transmission and Reception with Antenna and Coil Aerials.* J. H. Dellinger. (42) Oct.
Transatlantic Radio Communication.* E. F. W. Alexanderson. (42) Oct.
New Electric Generating Station at Denver.* H. H. Kerr and T. O. Kennedy. (111) Oct. 1.
Calibrating Standard Watt-Hour Meters.* F. A. Kartak. (27) Oct. 4.
Efficient Operation of Central Power Stations.* J. D. Morgan. (64) Oct. 7.
The Three-Electrode Thermionic Valve as A. C. Generator.* C. L. Fortescue. (Abstract of paper read before British Assoc.) (26) Oct. 10; (11) Oct. 11.
Cost of Building a 33 000 Volt Line. (27) Oct. 11.
Composite Transmission Structures of Steel and Wood.* F. C. Weiss. (117) Oct. 15.
Direction Finding by Wireless Telegraphy.* Riall Sankey (From paper read before Olympia Exhibition.) (12) Oct. 17.
The Improvement of Power Factor.* E. W. Dorey. (26) Serial beginning Oct. 17.
Electrolytic Production of Hydrogen and Oxygen. (11) Oct. 17.
Energization of the Ignition Coil.* Harry F. Geist. (120) Oct. 23.
A Back E. M. F. Booster.* G. Bouron. (73) Oct. 24.
Form Factor.* F. M. Denton. (73) Oct. 24.
Notes on the Localisation of Breaks or Faults in Submarine Cables.* J. F. Lloyd. (73) Oct. 31.
Present Limits of Speed and Power of Single Shaft Curtis Steam Turbines.* Eskil Berg. (42) Nov.
Present Limits of Speed and Output of Single-Shaft Turbo Generators.* F. D. Newbury (42) Nov.
Present Limits of Speed and Power of Single-Shaft Steam Turbines.* J. F. Johnson. (42) Nov.
Telephone Repeaters.* Bancroft Gherardi and Frank B. Jewett. (42) Nov.
Aircraft Telephony.* B. S. Cohen. (Abstract of paper read before Inst. of Post Office Elec. Engrs.) (73) Serial beginning Nov. 14.
Improvement of Power Factor in Electrical Supply Systems.* (12) Nov. 14.
Recording of Eiffel Tower Time Signals for Determination of Clock Error.* L. B. Turner. (73) Nov. 14.
Hydroelectric Plant and Paper Mill at Ocean Falls, B. C.* W. A. Scott. (117) Nov. 15.
The Electrical Gyro Compass.* (117) Nov. 15.
The New Physics.* A. C. Crehore. (111) Serial beginning Nov. 15.
Connexions à la Terre des Systèmes de Distribution Electrique. (33) May 31.
Les Applications du Chauffage Electrique dans l'Industrie.* F. Rutgers. (33) Aug. 30.
Die jüngsten Fortschritte in der Beurteilung und Bekämpfung von Ueberspannungen in Elektrischen Anlagen.* W. Kummer. (107) Serial beginning July 26.

Marine.

Hog Island, The Greatest Shipyard in the World.* W. H. Blood. (91) Vol. 26, 1918.
The Application of Electric Welding to Ship Construction.* H. Jasper Cox. (91) Vol. 26, 1918.
Present Status of the Concrete Ship.* R. J. Wig. (91) Vol. 26, 1918.
Variations of Shaft Horse-Power, Propellor Revolutions, and Propulsive Coefficient with Longitudinal Position of the Parallel Middle Body in a Single-Screw Cargo Ship.* William McEntee. (91) Vol. 26, 1918.
Recent Developments in Shipyard Plants. S. M. Henry. (91) Vol. 26, 1918.
Experiments on Simplified Ship Forms.* H. C. Sadler and T. Yamamoto. (91) Vol. 26, 1918.
On Vibrations of Beams of Variable Cross-Section. N. W. Akimoff. (91) Vol. 26, 1918.
Structural Steel Standardized Cargo Vessels.* Henry R. Sutphen. (91) Vol. 26, 1918.
Side Launching of Ships on the Great Lakes.* Frank E. Kirby and Edward Hopkins. (91) Vol. 26, 1918.
Notes on Launching.* William Gatewood. (91) Vol. 26, 1918.
Progress in Turbine Ship Propulsion.* Francis Hodgkinson. (91) Vol. 26, 1918.
Application of Buoyancy Boxes to the Steamship *Lucia* for the United States Shipping Board.* W. T. Donnelly. (91) Vol. 26, 1918.
The Michell Journal Bearing.* (For Marine Engines.) (12) Aug. 29.

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* Illustrated.

Marine—(Continued).

Air Flow Over Rear Deck of Battleship *Pennsylvania*.* A. F. Zahm. (3) Sept.
Torpedo-Boat Destroyers in the Making.* James Reed. (**55**) Sept.
Steel Corporation's Alabama Developments.* (For Shipbuilding.) (**20**) Sept. 4.
Crane Lighter No. 4.* (**12**) Sept. 5.
Steam Turbines and Gears for Marine Service.* Geo. H. Gibson. (**64**) Sept. 9.
Precast Members Used for British Concrete Barges.* (**13**) Sept. 11.
Rapid Concreting a Feature of Big Portsmouth Dry Dock. (**13**) Sept. 11.
Salvage by Floating Towers of Concrete.* F. Rowlinson. (**46**) Sept. 13.
An Electrically Driven Battleship.* C. M. Ripley. (**111**) Sept. 15.
New Data on Ship Stresses.* (**13**) Sept. 18.
The Paravane.* Robert F. McKay. (Paper read before British Assoc.) (**11**) Sept. 19.
Development of Geared Turbines for the Propulsion of Ships.* R. J. Walker. (Paper read before British Assoc.) (**11**) Sept. 19.
The Equipment of the Commonwealth Dry Dock at Boston, Mass.* Frank W. Hodgdon. (**109**) Oct.
The New Dry Dock at Norfolk.* Harry Gardner. (**117**) Oct. 15.
Heavy Double Trestle for Shipbuilding Cranes Over Newport News Battle-Cruiser Berths.* R. W. Burpee. (**13**) Oct. 16.
New Shipways at Newport News Departure from Ordinary Practice.* A. F. Mattson. (**86**) Oct. 22.
Electric Welding and Its Application to Shipbuilding.* (**12**) Serial beginning Oct. 31.
Power and Speed of Steamers.* Arthur R. Liddell. (**12**) Oct. 31.
Stresses in Thin Shells of Circular Section. (For Shipbuilding.) (**11**) Nov. 14.
Etude des Ondes Acoustiques, la Propagation des Ondes Vibratoires et l'Ecoute Sous-Marine. H. Brillié. (**33**) Serial beginning Aug. 23.
Die Wiederherstellung der deutschen Handelsflotte. W. Kreul. (**50**) Feb. 14, 1918.
Schiffe aus Eisenbeton.* A. Guttmann. (**50**) Serial beginning July 4, 1918.

Mechanical.

Use of Pulverized Coal, with Special Reference to Its Application in Metallurgy.* L. C. Harvey. (**71**) Vol. 99.
Some Points in the Manufacture of Files.* Geo. Taylor. (**71**) Vol. 99.
Feed-Water Treating and Purifying Plant for the Republic Iron and Steel Company, Youngstown, Ohio. S. H. McKee. (**58**) July.
Pneumatic-Electric Rock Drill and Some of the Tools Used in Its Construction.* Frank A. Stanley. (**72**) Serial beginning July 17.
Lubrication of Air Compressors.* H. V. Conrad. (From paper read before Compressed Air Soc.) (**72**) July 24.
Fuel Economy in the Production of Power at the Apedale Works of the Midland Coal, Coke & Iron Co., Ltd., Apedale, Newcastle, Staffordshire. William Hill and J. A. Cork. (**106**) Aug.
Trench Machinery.* A. E. Collins. (**114**) Aug. 16.
Benzol in Coal.* M. E. Sainte-Claire-Deville. (From paper read before Société Technique du Gaz.) (**66**) Aug. 19.
Turbo-Gear Manufacture.* E. A. Suverkrop. (**72**) Aug. 21.
Factors Limiting the Maximum Pressures Developed in Gaseous Explosions.* W. T. David. (**11**) Aug. 22.
A Seaplane Wireless Transmitting Set.* (From the *T. and T. Age.*) (**26**) Aug. 22.
The Carbonization of Coal and the Utilization of the Waste Heat and Gases. W. T. Lane. (From *Proceedings* of South Wales Inst. of Engrs.) (**66**) Aug. 26.
Design and Construction Features of Concrete Fuel Oil Tanks. H. B. Andrews. (**86**) Aug. 27.
Strength and Other Properties of Wire Rope. (U. S. Bureau of Standards.) (**86**) Aug. 27.
Aerial Bomb Sights.* (**12**) Aug. 29.
Some Notes on the Vickers Diesel Engine.* (**12**) Aug. 29.
Shortcomings of the Water-Gas Process. John Harger. (From *The Chemical Age.*) (**24**) Aug. 30.
Fire Protection for Oil Tanks.* (**16**) Aug. 30.
The Examination of Coal in Relation to Coal-Washing.* M. Wynter Blyth and L. T. O'Shea. (**106**) Sept.
Building Up a Worn Pump with the Oxy-Acetylene Process.* Charles C. Phelps. (**60**) Sept.
Fuel Saving in Industrial Plants.* John F. Tinsley. (**55**) Sept.
Pulverized Coal as a Fuel for Boilers.* Edward R. Welles and W. H. Jacobi. (**55**) Sept.
The Horsepower of Resistance in Aeroplane Design.* N. L. Lieberman. (**55**) Sept.
Burning Pulverized Coal Under the Boiler.* Frederick A. Scheffler and H. G. Barnhurst. (Paper read before Am. Soc. of Mech. Engrs.) (**116**) Sept.

* Illustrated.

Mechanical—(Continued).

Blue Water Gas as a Metallurgical Fuel.* A. E. Blake. (116) Sept.
Increasing Wet Gas Washer Efficiency.* George B. Cramp. (116) Sept.
Modern Methods of Fine Grinding. George S. Emerick. (67) Sept.
Carbonization of Coal. W. C. Kirkpatrick. (117) Sept. 1.
Ammonia in Producer Gas.* F. K. Ovitz. (Bureau of Mines.) (105) Sept. 1.
Coking of Illinois Coal in Koppers Type Oven.* R. S. McBride and W. A. Selvig. (Bureau of Standards.) (83) Sept. 1.
Influence of Load on Pressures of Oil and Atomizing Steam in Oil Burners.* C. R. Weymouth. (111) Sept. 1.
Oxy-Acetylene Welding Instruction for Shop Work.* Alfred S. Kinsey. (Paper read before Acetylene Assoc.). (83) Sept. 1.
Separation of Costs in a Combined Steam-Heating and Electric Plant.* H. W. Meyer. (64) Sept. 2.
Flywheel Bursts at Racine, Wis.* (64) Sept. 2.
The Limits of Thermal Efficiency in Internal-Combustion Engines.* Dugald Clark. (From paper read before the North East Coast Inst. of Engrs. and Shipbuilders.) (64) Sept. 2.
Straightening Shaft of 45 000-Kw. Turbine.* E. E. Clock. (64) Sept. 2.
Energy Stored in a Steam Boiler.* Fred R. Low. (64) Sept. 2.
Refinements in Turbine Design.* A. G. Christie. (64) Sept. 2.
Factors Affecting the Life of Lead-Acid Storage Batteries.* P. L. Rittenhouse. (Paper read before National Gas Engine Assoc.) (120) Sept. 4.
The Economical Employment of Gravity Conveyors.* J. Edward Schipper. (120) Sept. 4.
Heavy Machine Equipment at Panama.* R. D. Gatewood. (72) Sept. 4.
A Friction Drive Relay Control for Aircraft.* A. Q. Cooper. (12) Sept. 5.
The Effect of Carbon Dioxide When Present in Inflammable Gaseous Mixtures on Explosion Phenomena.* W. T. David. (11) Sept. 5.
Selecting Wood for Airplanes.* Arthur Koehler. (19) Sept. 6.
Using Indicator on Internal Combustion Engines.* Ralph Miller. (64) Sept. 9.
The Possibilities of New Fuel Mixtures for Internal-Combustion Engines.* E. Humboldt. (64) Sept. 9.
Coal and Wood Furnaces Under Stirling Boilers.* (64) Sept. 9.
Low Grade Gas.* William Cranfield. (William Young Memorial Lecture.) (66) Sept. 9.
Steaming Horizontals.* R. J. Rew. (66) Sept. 9.
Pulverized Coal Plant of Puget Sound Traction, Light and Power Co. (From *Stone and Webster Journal.*) (86) Sept. 10.
Economy in Industrial Fuel Oil Furnaces.* Max Sklovskys. (72) Sept. 11.
A War Time Lesson on Reduction Gears.* (120) Sept. 11.
German Type of Double Rotary Aircraft Engine.* (120) Sept. 11.
The Testing of Materials. (For Automobiles.) Walter Rosenhain. (120) Sept. 11.
New Coke Plant of La Belle Iron Works.* (20) Sept. 11.
Notched Bar Tests.* W. C. Unwin. (11) Sept. 12.
The Crossley Cold-Starting Heavy Oil Engine.* (12) Sept. 12.
British Thread Milling Machines.* (12) Serial beginning Sept. 12.
Oxy-Hydrogen Gas—Its Uses at the J. I. Case Threshing Machine Company, Manufacturers of Tractors and Farm Implements.* Charles Kandel. (24) Sept. 13.
Airplane Propeller Manufacture. A. L. Heim. (19) Sept. 13.
Symposium on Refractories. (For Brick.) (Am. Chemical Soc.) (105) Sept. 15.
Industrial Analysis of Gas Mixtures by the Refractometric Method.* Marcel Pouchon. (Abstract from article in *Chimie et Industrie.*) (105) Sept. 15.
Temperatures in By-Product Coke Oven Practice.* R. S. McBride and W. A. Selwig. (From *Technologic Papers* of U. S. Bureau of Standards.) (83) Sept. 15; (11) Oct. 17.
Methods of Removing Steam Shovels.* J. R. Sherman. (86) Sept. 17.
Application of Liberty Engine Materials to the Automotive Industry.* Harold F. Wood. (Paper read before Soc. of Automotive Engrs.) (72) Sept. 18.
Constitutional Defect of Four-Cylinder Engine and Remedy.* Laurence H. Pomeroy. (120) Sept. 18.
A Complete Theory of the Screw Propeller Working in Air.* M. A. S. Riach. (11) Sept. 19.
Engine Crankshafts: Some Causes of Failure. Edward Ingham. (26) Sept. 19.
Adopting Munitions Plant to Peace-Time Work.* (27) Sept. 20.
The Diesel Engine in the Southwest.* B. V. E. Nordberg. (16) Sept. 20.
Alcohol Motor Fuel. (Summary of Report of Long Interdepartmental Committee of Great Britain.) (19) Sept. 20.
Loss Due to Carbon in Furnace Refuse.* C. H. Berry. (64) Sept. 23.
Automatic Pump Control.* B. N. Everett. (64) Sept. 23.
Methods of Obtaining Close Speed Regulation. W. Trinks. (64) Sept. 23.
Mechanical Handling of Foundry Material.* (20) Sept. 25.
Scale Effects in Relation to Aerodynamics.* H. Levy. (120) Sept. 25.

* Illustrated.

Mechanical—(Continued).

Testing Airplane Wing Ribs for Strength.* Armin Elmendorf. (120) Sept. 25.
Coal Washing on Concentrating Tables. J. B. Morrow. (Paper read before Rocky Mountain Coal Min. Inst.) (45) Sept. 25.
The Classification of Coals.* R. W. Atkinson. (57) Sept. 26.
Easily Effected Economies in the Retort House.* Carl B. Wyckoff. (24) Sept. 27.
Large Government Storage Plant for Chicago.* (Refrigerating Plant.) (64) Sept. 30.
The Relation of Time of Ignition to the Economy of the Gasoline Engine.* J. P. Calderwood and A. J. Mack. (64) Sept. 30.
Reduced Quality of Gas; Methods of Dilution. (118) Oct.
Petrol in Natural Gas; Methods of Recovery. (From *Bulletin* issued by the U. S. Bureau of Mines.) (118) Oct.
Benzol as an Engine Fuel. Eric W. Walford. (From *The Autocar.*) (2) Oct.
Refractory Materials and High Temperature Measurements. C. W. Kanolt. (3) Oct.
Air Speed Indicators for Dirigibles. A. F. Zahm. (The Aeronautics Staff, U. S. N.) (3) Oct.
Inspection of Leather Belting.* Harry A. Hey. (9) Oct.
Industrial Uses of Superheated Steam.* Alexander Bradley. (From paper read before Am. Soc. of Heating and Ventilating Engrs.) (116) Oct.
Gage Limits in Interchangeable Manufacture. E. C. Peck. (55) Oct.
The Lubrication of Ball-Bearings.* H. R. Trotter. (55) Oct.
Centrifugal Compressors.* Gustave Fluegel. (From *Zeitschrift des Vereines deutscher Ingenieure.*) (55) Oct.
Increasing Primary Cooler Efficiency.* George B. Cramp. (116) Oct.
General Rules for Figuring Belting. (117) Oct. 1.
Power Transmission Groups of the German Trucks.* Arthur J. Slade. (120) Oct. 2; (120) Oct. 23.
Test Shows 82.1 Per Cent. Over-All Efficiency of Motor-Driven Centrifugal Pump.* R. N. Austin. (96) Oct. 2.
The Ingersoll Differential Type Continuous Milling Machine.* J. U. Hunter. (72) Oct. 2.
Ammonia from Coal. M. Meredith. (45) Oct. 2.
Experimental Retort Tests of Orient Coal.* R. S. McBride and I. V. Brumbaugh. (U. S. Bureau of Standards.) (45) Oct. 2.
Some Boiler-House Economics.* E. P. Humphrey. (45) Oct. 2.
Up-to-Date Plant of the Buckeye Coal Company at Nemacolin (Pa.).* Donald J. Baker. (45) Oct. 2.
Strength and Other Properties of Wire Rope. J. H. Griffith and J. G. Bragg. (From paper issued by U. S. Bureau of Standards.) (57) Oct. 3.
The Action of Pyridine Upon the Coal Substance. William A. Bone and Reginald J. Sarjant. (Abstract of paper read before Royal Soc.) (57) Oct. 3.
A Good Joint is Tight and Free from Leakage; Inexpensive and Easy to Make Up—Cement Joint Fills the Bill.* W. M. Henderson. (Paper read before Pacific Coast Gas Assoc.) (24) Oct. 4; (83) Oct. 15.
Water Gas and Coal Conservation.* S. Moore. (Paper read before Eastern Counties Gas Managers Assoc.) (66) Oct. 7.
Reinforced Concrete Pipe Made by the Centrifugal Process.* E. M. Weston. (13) Oct. 9.
The Scientific Progress of Aviation During the War.* L. Bairstow. (Paper read before British Assoc.) (11) Oct. 10.
Gas Engine of To-Day No Longer the Uncertain Quantity It Once Was.* F. H. Bivens. (Paper read before Pacific Coast Gas Assoc.) (24) Oct. 11.
Coal Crushing in a By-Product Coke Oven Plant. (83) Oct. 15.
Building a Large Gas Tank.* R. E. Sperry. (117) Oct. 15.
Boiler Insulation Practice in Oil-Burning Steam Plants.* A. L. Gossman. (111) Oct. 15.
The Steam Jet Ash Conveyor.* I. A. Peebles. (45) Oct. 16.
The Effects of Kiln-Drying On Commercial White Ash.* H. J. Rosenthal. (For Airplanes.) (120) Oct. 16.
Engine Power and Height.* H. T. Tizard. (Paper read before British Assoc.) (11) Serial beginning Oct. 17.
In Order to Determine the Relative Efficiency of a Gas Machine It is Necessary to be Able to Determine at Any Time the Quantity and Quality of Gas Which the Machine is Producing.* R. A. Carter, Jr. (Paper read before Am. Gas Assoc.) (24) Oct. 18.
Vertical Retorts Lend Themselves to Steaming with Better Results than in the Case of Horizontals. L. J. Willien, Jr. (Paper read before Am. Gas Assoc.) (24) Oct. 18.
Flame Velocity in Inflammable Gases. J. D. Morgan. (11) Oct. 24.

* Illustrated.

Mechanical– (Continued).

Heating Problems Produced by Some of the Modern Methods of Building Construction. (5) Nov.

Most Recent Development in Cement Plant Potash Recovery.* (67) Nov.

Present Limits of Speed and Power of Single-Shaft Steam Turbines.* J. F. Johnson. (42) Nov.

Present Limits of Speed and Power of Single Shaft Curtis Steam Turbines.* Eskil Berg. (42) Nov.

Cast Iron Pipe Joint Tests Made at Schenectady.* Victor Starzenski. (83) Nov. 1.

Recommend Deeper Bell and Elimination of Lead Groove for Cast Iron Pipe to be Jointed with Cement. (From Report of Committee of Am. Gas. Assoc.) (24) Nov. 8.

At Zinc Works, Aim is to Tend Towards Less Desirable Coals and Build Up a Producer Practice That can Handle Lower Cost Materials. G. S. Brooks and C. C. Nitchie. (24) Nov. 15.

Sur le Calibrage des Profils à Trois Branches Convergeant en un Même Point.* Norbert Metz. (93) Mar.

XLII^e Congrès de la Société Technique du Gaz, Metz, 4-5 juillet 1919.* (33) Serial beginning Aug. 2.

Etude Mathématique du Fonctionnement des Carburateurs à Giclage et à Niveau Constant.* M. Carbonaro. (33) Serial beginning Aug. 2.

L'Aérostation Maritime.* Emile Gouault. (33) Aug. 16.

Trockengas-Generator, Bauart Georgs-marienhütte.* Max Bräutigam. (50) Mar. 7, 1918.

Massentransport und Massenumschlag nach dem Kriege.* Richard Borchers. (50) June 13, 1918.

Die rechnerische Nachprüfung und Ergänzung der Kuppelofengasanalyse. Naegell. (50) June 27, 1918.

Die Massenerzeugung von schwierigem Automobilguss, insbesondere von Zylindergehäusen.* Carl Irresberger. (50) June 27, 1918.

Ueber Schlackenabstichgaserzeuger im Vergleich zu solchen mit Wasserabschluss. H. Markgraf. (50) Serial beginning July 18, 1918.

Die Giesserei der Buick Motor Co. in Flint, Mich., ein Grossbetrieb für Automobilguss.* C. Irresberger. (50) July 25, 1918.

Ein Kapital aus der Gaswirtschaft. Friedrich Siemens. (50) Aug. 15, 1918.

Koks und Kohle als Gaserzeugerbrennstoff. D. J. Hudler. (50) Aug. 22, 1918.

Die Wirtschaftlichkeit von Nebenerzeugnisanlagen für Kraftwerk.* G. Klingenberg. (50) Serial beginning Jan. 3.

Die Messung des Dampfverbrauches mittels stark erweiterter Messdüsen und der Wirkungsgrad von Curtis-Stufen. Georg Forner. (48) Jan. 25.

Eine neuartige Festigkeitsmaschine.* Georg Wazau. (48) Jan. 25.

Elektrische Aurüstungen von Hebezeugen und Transportmaschinen in Hüttenwerken. C. Schiebeler. (50) Feb. 6.

Bruch von Giesspfannengehängen.* C. Senssenbrenner. (50) Feb. 27.

Beiträge zur Erhöhung der Ammoniakausbeute bei der Destillation der Steinkohle. Friedrich Sommer. (50) Serial beginning Mar. 13.

Einige Sätze über die Kettenlinie.* A. Kiefer. (107) Serial beginning Mar. 22.

Stahlgussketten. Richard Krieger. (50) Serial beginning Mar. 27.

Die Kettenlinie im Ingenieurwesen.* J. Brunner. (107) July 12.

Die Entwicklung des elektrischen Fördermaschinen-Antriebes.* (107) Serial beginning Aug. 23.

Von den Kartoffel-Trocknungsanlagen des Eidgenössischen Ernährungsamtes.* Ulr. Bühlmann. (107) Aug. 30.

Metallurgical.

Use of Pulverized Coal, with Special Reference to Its Application in Metallurgy.* L. C. Harvey. (71) Vol. 99.

Modern Steel Metallurgy. (Calculation and Comparison of Process.) Chas. H. F. Bagley. (71) Vol. 99.

The Acid Hearth and Slag.* J. H. Whiteley and A. F. Hollimond. (71) Vol. 99.

Deoxidation, and the Influence of Lime on Equilibrium in the Acid Open-Hearth Furnace. B. Yaneske. (71) Vol. 99.

Macro-Etching and Macro-Printing.* J. C. W. Humfrey. (71) Vol. 99.

The Manufacture and Working of High-Speed Steel.* J. H. Andrew and G. W. Green. (71) Vol. 99.

Improvements in the Case-Hardening Process.* D. Hanson and J. E. Hurst. (71) Vol. 99.

The Molecular Constitutions of High-Speed Tool Steels and Their Correlations with Lathe Efficiencies.* John Oliver Arnold and Fred Ibbotson. (71) Vol. 99.

Note on Surface Tension Effects in High-Speed Steels. F. C. Thompson. (71) Vol. 99.

The Carburisation of Iron at Low Temperatures.* Andrew McCance. (71) Vol. 99.

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* Illustrated.

Metallurgical—(Continued).

Notes on the Liquidus in the Iron-Carbon Diagram.* G. Cesàre. (**71**) Vol. 99.
On the Non-Allotropic Nature of the A-2 Transformation in Iron.* Kôtarô Houda. (**71**) Vol. 99.
The Experimental Investigation of the Influence of the Rate of Cooling on the Hardening of Carbon Steels.* A. M. Portevin and M. Garvin. (**71**) Vol. 99.
Graphitization in Iron-Carbon Alloys.* Kuniichi Tawara and Genshichi Asahara. (**71**) Vol. 99.
The Estimation of Phosphorus in the Presence of Tungsten.* G. Watson Gray and James Smith. (**71**) Vol. 99.
Welding Mild Steel.* H. M. Hobart. (**42**) Apr.
Fatigue of Metals Under Repeated Stress.* Herbert F. Moore. (**4**) June.
A Complete and Modern Heat-Treating Plant.* L. A. Dause. (**72**) July 24.
Pulverized Coal in Blast Furnaces. (**22**) Aug. 15.
Fusion Welding as Applied to Drop-Forging.* S. W. Miller. (Abstract of paper read before Am. Drop Forge Assoc.) (**72**) Aug. 21.
Cast Iron Under Heat Influences.* E. Adamson. (**22**) Aug. 22.
The Effect of Work on Metals and Alloys.* Owen Wm. Ellis. (Paper read before the Inst. of Metals.) (**11**) Aug. 29.
Treatment of Tailing and Ore in the Sweeny Mill.* R. S. Handy. (**103**) Aug. 30.
Overfired Car Type Annealing Furnace.* (**116**) Sept.
Reducing Non-Metallic Impurities in Steel. L. B. Lindemuth. (**116**) Sept.
Atlas Crucible Steel Increases Capacity for Making and Rolling High Grade Steels.* H. Donald Dickinson. (**116**) Sept.
Practical Notes on Physical Tests of Steel.* Austin B. Wilson. (**116**) Serial beginning Sept.
The Heat Treatment of Track Materials. C. B. Bronson. (Abstract of paper read before Am. Steel Treaters' Soc.) (**86**) Sept.
Fatigue Phenomena in Metals.* (**55**) Sept.
New Structural Mill at Kiushu Steel Works. Japanese Increase Steel Production.* (**116**) Sept.
Practical Notes on Physical Tests of Steel.* Austin B. Wilson. (**62**) Serial beginning Sept.
Overfired Car Type Annealing Furnace.* (**62**) Sept.
A New Compensated Heatmeter.* Charles P. Frey. (**105**) Sept. 1.
Electric Production of Carbon-Free Alloys.* E. F. Northrup. (**105**) Sept. 1.
Air Apparatus for Determining the Thermal Conductivity of Metals.* Gordon B. Wilkes. (**105**) Sept. 1.
The Design of Electric Furnaces. R. C. Gosrow. (**105**) Sept. 1.
Metallography of Aluminum Ingot.* Robert J. Anderson. (U. S. Bureau of Mines.) (**105**) Sept. 1.
The No. 1 Concentrator of the Mountain Copper Company.* Lloyd C. White. (**103**) Sept. 6.
A New South Wales Lead Smeltery * (From *Proceedings* of the Australasian Inst. of Min. Engrs.) (**16**) Sept. 6; (**103**) Aug. 30.
Working Monel Metal.* Hugh R. Williams. (**72**) Sept. 11.
The Properties of Some Copper Alloys.* W. Rosenhain. (Paper read before Inst. of Metals.) (**12**) Sept. 12.
New Screen-Sizing Scale Proposed.* Edward H. Robie. (**16**) Sept. 13.
Notes on the Metallurgy of Wulfenite.* J. P. Bonardi. (**105**) Sept. 15.
Application of the Cottrell Process to the Recovery of Fume from Silver Refining Operations.* W. G. Smith and A. A. Heimrod. (**105**) Sept. 15.
Commercial Testing of Metallurgical Electric Furnaces.* H. M. St. John. (**105**) Sept. 15.
New Methods Speed Up Foundry Output.* (**20**) Sept. 18.
Fuel Economy in Cupola Practice.* H. J. Yates. (**11**) Sept. 19.
Fuel Economy in the Iron and Steel Manufacture.* William A. Bone. (Report before Iron and Steel Inst.) (**11**) Serial beginning Sept. 19.
Notes on Troubles from Colloids in Flotation. (**16**) Sept. 20.
Operating Brass-Making Induction Furnaces.* R. N. Blakeslee, Jr. (**27**) Sept. 20.
Experiences in Electric Steel Foundry.* (**27**) Sept. 20.
Centrifugally Cast Pipe in South America.* (**20**) Sept. 25.
Economies in a Malleable Iron Foundry.* A. F. Conant. (**20**) Sept. 25.
Silico-Manganese for Steel Castings. E. F. Cone. (**20**) Sept. 25.
Effects of the Chemical Composition of Welding Electrodes.* J. S. Orton. (**72**) Sept. 25.
Moulding-Sands for Non-Ferrous Foundry Work.* P. G. H. Boswell. (Paper read before Inst. of Metals.) (**11**) Serial beginning Sept. 26.
Electrical Practice in the Equipment of Blast Furnace Plant.* J. Percy Hodges. (**73**) Sept. 26.
Stress Lines in Steel After Permanent Deformation.* Andrew McCance. (From *Transactions*, Inst. Eng. and Ship Building.) (**19**) Sept. 27.

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* Illustrated.

Metallurgical—(Continued).

The Positions of Atoms in Metals.* A. W. Hull. (42) Oct.
Weirton Blows in New Blast Furnace.* (116) Oct.
Special Transformer Delivers Arc Voltage.* C. J. Holslag. (Paper read before Assoc. of Iron and Steel Elec. Engrs.) (116) Oct.
Direct and Alternate Current Welding.* A. M. Candy. (Paper read before Assoc. of Iron and Steel Elec. Engrs.) (116) Oct.
Constant and Variable Voltage Systems.* A. M. Bennett. (Arc-Welding.) (Paper read before Assoc. of Iron and Steel Elec. Engrs.) (116) Oct.
The Constant Potential Welding System.* Alexander Churchward. (Paper read before Assoc. of Iron and Steel Elec. Engrs.) (116) Oct.
Arc Welding Equipment for Steel Mills.* H. L. Unland. (Paper read before Assoc. of Iron and Steel Elec. Engrs.) (116) Oct.
Electric Furnace Replaces Crucibles.* (20) Oct. 2.
Season Cracking.* W. H. Hatfield. (Paper read before Inst. of Metals.) (11) Oct. 3.
The New Elmore Process. (From *The Mining Magazine.*) (103) Oct. 4.
The Micro-Mechanism of the Ageing of Duralumin. Zay Jeffries. (Paper read before Inst. of Metals.) (11) Oct. 10.
Cargo Fleet Iron Company's Extensions.* (Blast Furnace.) (22) Oct. 24.
Observations on a Typical Bearing Metal.* Hikla E. Fry and W. Rosenhain. (Paper read before Inst. of Metals.) (11) Oct. 24.
New American Blast Furnace Plant.* (22) Oct. 31.
Allis-Chalmers Heavy Forging Plant.* (62) Nov.
The Anatomy of a Drop Forging.* Leslie Aitchison. (From paper read before Midland Inst.) (62) Nov.
Correct Heat Treatment of Cast Steel. Alvin N. Couarroe. (62) Nov.
Pyrometry in the Steel Industry. Richard P. Brown. (62) Serial beginning Nov.
The Solidification of Metals from the Liquid State.* Cecil H. Desch. (Paper read before Inst. of Metals.) (11) Nov. 7.
The Ternary Alloys of Tin-Antimony-Arsenic.* J. E. Stead. (Paper read before Inst. of Metals.) (11) Nov. 14.
Rapport sur les Essais Effectues sur les Briques de Silice à l'Usine des Dunes.* Philipon. (93) Nov., 1918.
Sur Quelques Appareils Destiné au Controle de la Fabrication des Briques de Silice.* H. Le Chatelier and B. Bogitch. (93) Nov., 1918.
Mécanisme de la Trempe des Aciers au Carbone.* Pierre Chevenard. (93) Jan.
Effet du Ravenu sur la Structure Micrographique des Aciers Hypseutectiques et des Alliages de Constitution Similaire.* A. Portevin. (93) Mar.
Sur la Dureté et la Resilience des Alliages Or-Cuivre.* A. Portevin and Jean Durand. (93) Mar.
Equipement Electrique Siemens pour la Commande d'un laminoir de 19 000 Chevaux.* (33) Aug. 9.
Fabrication, Propriétés et Utilisation Industrielle du Fer Electrolytique.* Jean Escard. (33) Serial beginning Aug. 23.
Der elektrische Schmelzofen von Grönwall-Dixon.* Carl Irresberger. (50) Jan. 31, 1918.
Die Vorausbestimmung der Fuchs-und Gichttemperatur beim Giessereiflammofen und Kuppelofen als Beispiele entwickelt. (50) Jan. 31, 1918.
Ueber die Bestimmung des Sauerstoffs im Eisen.* P. Oberhoffer. (50) Feb. 7, 1918.
Selbsttätige Elektroden-Regelvorrichtungen für Lichtbogen-Elektro-Oefen. W. Kunze. (50) Serial beginning Feb. 14, 1918.
Die Raumverteilung in Stahlformgiessereien; ein Betrag zur Frage des Entwurfes von Giessereien. Carl Irresberger. (50) Feb. 28, 1918.
Richtlinien für die Erforschung der Formänderung bildsamer Körper, inbesondere des Arbeitsbedarfs beim Walzen. K. Rummel. (50) Serial beginning Mar. 6.
Die Bedeutung der Ukraine in der russischen Eisen-Industrie. Hugo Klein. (50) Mar. 21, 1918.
Ueber den Betrieb der steinernen Winderhitzer. (50) Mar. 21, 1918.
Neues aus der Praxis des Emaillierens. J. Schaefer. (50) Mar. 28, 1918.
Der Umbau des Hochofenwerkes Eisenhütte I der Gutehoffnungshütte zu Oberhausen, Rhld.* Max Weidler. (50) Serial beginning Apr. 4, 1918.
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Ueber den Koksverbrauch im Hochofen.* Fr. Lange. (50) Apr. 11, 1918.
Zur Bestimmung der Walzarbeit. E. Cotel. (50) Apr. 18, 1918.
Das behördliche Verfahren bei der Errichtung industrieller Anlagen. Friedrich Syrup. (50) Apr. 18, 1918.
Russlands Eisenverbrauch.* (50) May 2, 1918.
Das Duplex-Verfahren in Amerika.* H. Illies. (50) May 16, 1918.
Einiges über die Cowperbeheizung. A. Pfoser. (50) June 20, 1918.

* Illustrated.

Metallurgical—(Continued).

Die augenblickliche Lage der südrussischen Eisenindustrie. Hugo Klein. **(50)** June 20, 1918.
Elektrischer Beizantrieb der Dillinger Hüttenwerke.* A. Nolte. **(50)** July 11, 1918.
Das Verhalten des Schwefels in der Thomasbirne. L. Blum. **(50)** July 11, 1918.
Bronzeguss in alter und neuer Zeit.* B. Förster. **(50)** July 25, 1918.
Zur Frage der Winderhitzung auf Hochofenwerken. Oskar Simmersbach. **(50)** Aug. 1, 1918.
Der Einfluss von schlecht gebranntem Kalk beim Thomasverfahren. Max Backheuer. **(50)** Aug. 15, 1918.
Erfahrungen in Schmelzen von Grauguss im Oelofen. Kurt Abeking. **(50)** Aug. 29, 1918.
Englands Wirtschaftskampf gegen die deutsche Eisen-und Stahlindustrie. H. Racine. **(50)** Sept. 5, 1918.
Aus der ukrainischen Eisenindustrie. Hugo Klein. **(50)** Sept. 19, 1918.
Die neue Hochofenbeschickungsanlage der Rheinischen Stahlwerke in Duisburg-Meiderich.* Adolf Küppers. **(50)** Sept. 19, 1918.
Ueber Vorgänge beim Heisswalzen mit Nutzanwendung für den Betrieb.* A. Sattmann. **(50)** Oct. 3, 1918.
Zur Frage der beschleunigten Cowperbeheizung (P. S. S.-Verfahren). Bernard Osann. **(50)** Oct. 3, 1918.
Vom Winderhitzerbau in den Vereinigten Staaten von Nordamerika. O. Höhl. **(50)** Oct. 10, 1918.
Die Metallographische Untersuchung des Weissblech.* Leo Mayer. **(50)** Oct. 17, 1918.
Ueber Verbrennungsvorgänge in hüttentechnischen Feuerungen. M. Escher. **(50)** Oct. 24, 1918.
Ueber die Heizung der steinernen Winderhitzer. D. G. Jantzen. **(50)** Nov. 18, 1918.
Die Grundlagen für die Anwendung betriebswissenschaftlicher Verfahren in der Gisserei. Siegfried Werner. **(50)** Nov. 28, 1918.
Ueber die Feinblech-Industrie in Südrussland.* L. Pletsch. **(50)** Serial beginning Dec. 5, 1918.
Zur Statistik der deutschen Eisenerzeugung im Kriege. R. Bierbauer. **(50)** Feb. 6.
Beiträge zur Kenntnis oxydischer Schlackeneinschlusse sowie der Desoxydationsvorgänge im Flusseisen.* P. Oberhoffer and K. d'Huart. **(50)** Serial beginning Feb. 13.
Zur Frage der sparsamen Verwendung von Eisen. Wilhelm Mertens. **(50)** Feb. 13.
Ueber Verbrennungsvorgänge in hüttentechnischen Feuerungen. **(50)** Mar. 6.
Ueber Manganstahl und dessen Herstellung für Stahlformguss in Héroult-Elektroofen Berthold Schudel. **(107)** Sept. 13.

Military.

Heavy Coast Artillery.* D. A. Tomlinson. **(4)** June.
The Difficulties and Dangers of Mine-Rescue Work on the Western Front; and Mining Operations Carried Out by Men Wearing Rescue-Apparatus.* D. Dale Logan. **(106)** Aug.
Accidents Due to Structural Defects of Apparatus or Injury to Apparatus; and The Future of the Proto Apparatus.* D. Dale Logan. **(106)** Aug.
Chemical Warfare. T. M. Chance. **(2)** Sept.
Bomb-Proofing the Winiereux Viaduct.* B. Ripley. **(5)** Sept.
Activities of the Construction Division, United States Army, and the Form of Contract Adopted. R. C. Marshall. **(109)** Sept.
The Field Mount for the 7-In. Navy Gun.* C. L. McCrea. **(72)** Sept. 11.
Account of the British Tanks Used in the War.* Eustace H. Tennyson d'Eyncourt. (Paper read before British Assoc.) **(11)** Serial beginning Sept. 12.
War Gases are of Vital Military Importance. Wm. L. Sibert. **(83)** Sept. 15.
The British 18-Pounder Quick-Firing Gun.* I. William Chubb. **(72)** Serial beginning Sept. 25.
Caterpillars and Their Construction.* K. H. Condit. **(72)** Serial beginning Sept. 25.
Portable Military Bridges.* C. E. Inglis. (Paper read before British Assoc.) **(12)** Serial beginning Sept. 26.
The Telemetric System of High Burst Ranging.* Montague Blundon. **(100)** Sept.-Oct.
Bridging the Rhine with German Pontoon Equipage.* S. C. Godfrey. **(100)** Sept.-Oct.
Notes on Army's Light-Railway Practice in France.* Paul McGeehan. **(13)** Oct. 2.

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* Illustrated.

Military—(Continued).

Bridge Engineering in Active Warfare.* Lewis E. Moore and Marshall W. McDonald. (13) Serial beginning Oct. 9.
Heavy Steel Highway Bridging at the Front.* A. C. Oxley. (96) Oct. 16.
Die Herstellung gusseiserner Granaten in Frankreich und England. Carl Irresberger. (50) Oct. 31, 1918.
Der Werkstoff einiger feindlicher Artilleriegeschosse.* E. H. Schulz and J. Goebel. (50) Dec. 12, 1918.
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Mining.

The Preservation of Mine Timber.* N. T. Williams. (106) July.
Electric Shot-Firing.* MM. Taffanel, Dautriche, Durr, and Perrin. (57) Aug. 15.
Economical Pumping by New Application of the Electric Turbine Pump.* L. Hughes. (22) Aug. 15.
Avoidable Degradation of Coal.* Benedict Shubart. (Paper read before the Rocky Mountain Coal Min. Inst) (45) Sept. 4.
A Small Stripping with Heavy Overburden.* Donald J. Baker. (45) Sept. 4.
The Strength of Pit Props and Head-Trees.* Henry Adams. (From *Journal* of the Soc. of Engrs.) (57) Sept. 5.
German Stone Dusting Experiments. C. Beyling. (From *Glückauf.*) (57) Sept. 5.
Graphic Charts for Petroleum Bore-Holes.* T. Sington. (11) Sept. 5.
Siberian Mines and Mining.* Chester W. Purington. (103) Sept. 6.
How the Drainage Problem of Edna No. 2 Mine Was Solved.* Donald J. Baker. (45) Sept. 11.
Diesel Engines in Mine Power-Plants.* C. Legrand. (103) Sept. 13.
Bulkheading Open Stopes.* M. E. Richards. (Paper read before Lake Superior Metal Mine Safety Conference.) (16) Sept. 13.
Modern Mine-Wiring Practice.* Terrell Croft. (45) Sept. 18.
Sinking the "H" Shaft at the Pabst Mine.* A. J. Wagner. (16) Sept. 20.
Selection of Power for Mine Service. E. Steck. (45) Sept. 25.
Mines of the Jasper Park Collieries, Limited, at Pocahontas, Alberta.* J. H. McMillan. (45) Sept. 25.
Some Engineering Features in Connection with the Utah Copper Company's Operations.* R. C. Gemmell. (103) Sept. 27.
Quarry Stripping with Conveyor and Steam Shovel. Oliver Bowles. (From *Bulletin* issued by U. S. Bureau of Mines.) (67) Oct.
Sinking and Concreting a Mine Shaft. (117) Oct. 1.
Shaft Sinking in Mines.* C. E. Knecht, H. Stuart Martin and others. (Abstracts of papers read before South African Inst. of Engrs.) (57) Serial beginning Oct. 3.
Shaft Sinking by the Cementation Process.* A. Hassam and T. T. Mawson. (Paper read before North Staffordshire Inst. of Min. Engrs.) (57) Oct. 3; (22) Oct. 3.
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Failures Caused by Defects in Winding Ropes.* (57) Serial beginning Oct. 24.
Accidents on Haulage Inclines.* V. Watteyne and L. Lebens. (From *Annales des Mines de Belgique.*) (57) Serial beginning Oct. 31.
Factors in Design of Sluices and Pipe Lines for Hydraulicing.* F. A. Goodale. (From The Colorado School of Mines *Magazine.*) (86) Nov. 19.
Safety Factors in the Use of Explosives in Quarrying. Walter O. Snelling. (Paper read before National Safety Council.) (86) Nov. 19.
Mining and Smelting near Monterrey, Mexico.* R. B. Brinsmade. (103) Nov. 22.
Ueber die Probenahme von Erzen und Kohlen.* (50) Serial beginning Jan. 10, 1918.
Manganerze in Russland. Hugo Klein. (50) Apr. 4, 1918.
Felssprengungen mit flüssiger Luft. J. Rebold. (107) July 12.

Miscellaneous.

Present Status of Industrial Lighting Codes.* G. H. Stickney. (42) Apr.
Industrial Personnel Relations. A. H. Young. (4) June.
Atmospheric Pollution from the Engineer's Standpoint.* John B. C. Kershaw. (From Report of Advisory Committee of Meteorological Office, London.) (12) Aug. 29.
The Hollerith System of Accountancy and Its Application to Public Works Accounts.* J. Hill. (114) Aug. 30.
The Magnesite Industry in the United States.* W. C. Phalen. (103) Aug. 30.
A Planning Department System.* John H. Black. (9) Sept.
The Philosophy of Costs. C. E. Knoeppel. (9) Sept.
Installing Management Methods in the Woodworking Industry.* Carle M. Bigelow. (9) Sept.

* Illustrated.

Miscellaneous—(Continued).

Activities of the Construction Division, United States Army, and the Form of Contract Adopted. R. C. Marshall (**109**) Sept.
Gas Works Carbonise Charcoal for Gas Masks.* W. E. Brophy. (**83**) Sept. 1.
The Flash and Burning Points of Gasoline-Kerosene Mixtures.* James T. Robson and James R. Withrow. (Paper read before Am. Inst. of Chemical Engrs.) (**105**) Sept. 1.
Chemical Affinity and Atomic Valence. G. Ciamician and M. Padoa. (**19**) Sept. 6.
Unit Costs for Use in Public Utility Appraisals.* R. L. Baldwin. (**13**) Sept. 11.
Increasing the Ammonia Yield. (**24**) Sept. 13.
The Allen-Moore Cell in the Pulp and Paper Mill.* F. H. Mitchell. (**105**) Sept. 15.
Glucinum. J. S. Negru. (**105**) Sept. 15.
Calculation of Hydrometer Degrees, Gravities and Weights with the Slide Rule. Wallace Savage. (**105**) Sept. 15.
Piece Work *versus* Day Labor in Hand Excavation. Everett N. Bryan. (**86**) Sept. 17.
The Kelley System of Payment to Contractors for Estimating. (From Report of Associated General Contractors of America.) (**96**) Sept. 18.
Engineering Organization and Routine.* George L. McCain. (**120**) Sept. 18.
Protection of Owners on Cost-Plus Contracts.* F. A. Wells. (**96**) Sept. 25.
Refrigeration Requirements of Chemical Warfare.* A. M. Heritage. (**55**) Oct.
Optics of the Air.* W. J. Humphreys. (**3**) Oct.
Observations Regarding Chlorine Cells. F. G. Wheeler. (**105**) Oct. 1.
Office Organization.* W. C. Jackson. (Paper read before Inst. of Gas Engrs. and Mgrs.) (**66**) Oct. 7.
Cost-Keeping in Cost-Plus Fixed-Fee Contracts.* F. A. Wells. (**117**) Oct. 15; (**86**) Oct. 15.
The Piezo Electric Effect in the Composite Rochelle Salt Crystal.* A. McL. Nicolson. (**42**) Nov.
H. W. Nelson's Plan of Payment for Estimating.* (Statement submitted to Associated General Contrs. of America.) (**96**) Nov. 6.
La Situation de l'Industrie française Comparée avec celle des Principaux Autres Pays. (**33**) Aug. 9.
Kohlen-, Koks- und Eisenpreise in den Vereinigten Staaten während des Weltkrieges. A. Argelander. (**50**) Aug. 15, 1918.
Die neuen Verbrauchs-und Verkehrssteuern. J. Blum. (**50**) Aug. 22, 1918.
Der gegenwärtige Stand der Pyrometrie.* A. Mahlke. (**50**) Serial beginning Nov. 7, 1918.
Die Eisenindustrie Italiens unter dem Kriege. Emil Jacob. (**50**) Nov. 21, 1918.
Die Eisenerzlagerstätten der ehemals russischen Gebiete (Gross-Russland, Urkaine, Finnland, Sibirien, Polen. Georg Berg. (**50**) Feb. 20.
Bauwerke im Reiche der Atome.* L. Zehnder. (**107**) Aug. 16.

Municipal.

Housing in Relation to Town Development. James Thomson. (**114**) Aug. 2.
The Planning of Residential Suburbs with Special Reference to Engineering Features. F. L. Olmsted. (Abstract of paper read before National Conference on City Planning.) (**60**) Oct.
Cost of Utilities and Street Improvements as Affected by the Size of Residence Lots.* Morris Knowles. (Paper read before Town Planning Conference at Ottawa.) (**96**) Oct. 23.
Rules of Practice for the Establishment of Street Widths and Their Subdivisions.* B. A. Haldeman. (Paper read before Town Planning Conference at Ottawa.) (**96**) Oct. 23.
Zoning. Edward M. Bassett. (**96**) Oct. 23.
Fundamental Considerations of City Planning. F. L. Olmsted. (Paper read before Town Planning Conference at Ottawa.) (**96**) Oct. 23.
Lot and Block Units for Homes of Moderate Price. Arthur Coleman Carney. (Paper read before Town Planning Inst. of Canada and Am. City Planning Inst.) (**96**) Oct. 30.
Housing and Town Planning.* Thomas Adams. (Paper read before Am. City Planning Inst.) (**96**) Nov. 6.
Sunshine in Relation to the Dwelling.* Julian Julian. (**114**) Nov. 8.
The Planning of Land in Relation to Municipal and Social Problems. Thos. Adams. (Excerpts from paper read before Am. Soc. for Municipal Impvts.) (**96**) Nov. 20.

Railroads.

Apparent Relation Between Rainfall and Durability of Zinc-Treated Cross-Ties. C. H. Teesdale and S. W. Allen. (**113**) Vol. 15.

---

* Illustrated.

Railroads—(Continued).

Report of Sub-Committee on Car Construction. (Am. Wood Preservers Assoc.) **(113)** Vol. 15.
Track Depression Leads to Difficulties.* **(87)** Aug. 29.
American Railway Materials in the Far East.* Frank Rhea. (From Report of Bureau of Foreign and Domestic Commerce.) **(15)** Aug. 29.
The Jersey Central Is Building a Modern Coal Pier.* **(15)** Aug. 29.
Maintenance of Air-Blast Transformers.* **(17)** Aug. 30.
Lame Engines and Their Effect on Fuel Consumption.* J. W. Hardy. (Abstract of paper read before International Railway Fuel Assoc.) **(25)** Sept.
Recent Examples of Turntable Design.* **(87)** Sept.
Pennsylvania has Novel Treating Plant. **(87)** Sept.
Pennsylvania Lines Mallet Locomotive.* **(25)** Sept.
Box Cars Built by C., M. & St. P.* **(25)** Sept.
Types of Valve Gear on French Locomotives.* W. G. Landon. **(25)** Sept.
Elevation of Tracks at Aurora.* W. T. Christine. **(117)** Sept. 1.
Large Train-Shed Raised without Traffic Interruption.* **(13)** Sept. 4.
Concrete Railway Track Support.* A. C. Irwin. (Abstract of paper read before Am. Concrete Inst.) **(96)** Sept. 4.
A Concrete Foundation for a Wooden Water Tank.* **(15)** Sept. 5.
A Complete Wood Preserving Plant Mounted on Cars.* **(15)** Sept. 5.
The Alternating Current Track-Circuit.* Douglas G. Gall. **(73)** Sept. 5.
Ebenezer Shops and Engine Terminal, P. R. R.* **(18)** Sept. 6.
Tapered-Floor Track Scales, Canadian Pacific Railway.* **(18)** Sept. 6.
A Pulverized Fuel Equipment for Locomotives.* **(15)** Sept. 12.
Concrete Packing Stops Settlement Over Tunnel.* E. E. Adams. **(15)** Sept. 12.
Rolling Stock of 1919.* Herbert T. Walker. **(46)** Sept. 13.
Railway Train Lighting.* E. Wanamaker. **(61)** Sept. 15.
Heat Treatment of Track Materials. C. B. Bronson. (Abstract from paper read before Am. Steel Treaters' Soc.) **(86)** Sept. 17.
Opportunities for American Signaling in Far East. Frank Rhea. (From Report issued by Dept. of Commerce.) **(15)** Sept. 19.
Terminal Improvements in East St. Louis.* **(18)** Sept. 20.
Improving Efficiency of Track Labor. C. A. Morse. (Paper read before Road-masters' and Maintenance of Way Assoc.) **(18)** Sept. 20; **(86)** Oct. 15.
Raising a Large Train Shed Under Traffic.* **(15)** Sept. 26.
Flathead Valley Branch, Northern Pacific Ry.: Features of the Construction Work.* **(18)** Sept. 27.
Notes on Army's Light-Railway Practice in France.* Paul McGeehan. **(13)** Oct. 2.
Minor Buildings of a Large Freight Terminal.* **(18)** Oct. 4.
Mikado Type Locomotives of the C. P. R.* **(18)** Oct. 11.
Report of Committee on Power Generation. (Am. Elec. Ry. Eng. Assoc.) **(17)** Oct. 11.
Report of Committee on Equipment.* (Am. Elec. Ry. Eng. Assoc.) **(17)** Oct. 11.
A New Trans-Andine Railway.* Carlos Tejada Sorzano. **(18)** Oct. 18.
Baltimore & Ohio Shops, Cumberland, Md.* **(18)** Oct. 18.
Reinforced Concrete Ties of Italian State Railways.* (From *Il Cemento.*) **(86)** Oct. 29.
Report on Methods and Equipment Used in Renewing Timber Bridges in Whole and in Part. (Am. Ry. Bridge and Bldg. Assoc.) **(87)** Nov.; **(18)** Nov. 1.
Report on Painting Metal Railway Structures. (Am. Ry. Bridge and Bldg. Assoc.) **(87)** Nov.
Report on the Economical Use and Storage of Fuel at Railway Pumping Stations. (Am. Ry. Bridge and Bldg. Assoc.) **(87)** Nov.
Railway Fire Protection Equipment.* C. R. Knowles. **(87)** Nov.
Railway Electrification in Australia.* **(18)** Nov. 1.
New Electric Locomotives for C. M. & St. P. Ry.* **(18)** Nov. 8.
Construction Railroad Along the Queenston-Chippawa Canal.* Harry Gardner. **(117)** Nov. 15.
Recent Tests on the Holding Power of Railroad Spikes.* (From *Bulletin* issued by Columbia Univ.) **(86)** Nov. 19.
Tests of the Holding Power of Track Spikes.* **(18)** Serial beginning Nov. 22.
L'Electrification des Chemins de Fer; Impressions de la Commission Envoyée aux Etats-Unis par le Ministre des Travaux Publics pour l'Etude de la Question Mauduit. **(33)** Aug. 30.
Ueber die Verwendung von Flusseisenblechen für Lokomotivfeuerbüchsen.* Oskar Simmersbach. **(50)** Mar. 21, 1918.
Die Holzfeuerung der Lokomotiven. W. Kesselring. **(107)** Sept. 20.
Ueber die Schüttelschwingungen des Kuppelstangentriebes.* Karl E. Müller. **(107)** Serial beginning Sept. 20.

---

* Illustrated.

Railroads, Street.

Track Welding by the Metallic Arc.* Cyril J. Hopkins. (26) Sept. 5.
Definition of Terms in Valuation Work. (From Report to be read before Am. Elec. Ry. Assoc.) (86) Sept. 17.
Laying Out a Power Transmission Line.* Charles R. Harte. (17) Sept. 20.
Blue Lights and Their Significance in the New York Subways.* Edward A. Porr. (17) Sept. 20.
Selection of Rails for Electric Railway Service.* R. C. Cram. (17) Sept. 20.
Symposium on the One-Man Safety Car. (Abstract of paper read before Transportation and Traffic Assoc.) (17) Oct. 11.
Gasoline vs. Electric Motor for Street Railway Service. Norman W. Storer. (Paper read before Am. Electric Railway Eng. Assoc.) (17) Oct. 11.
Motorwagen und Anhängewagen neuer Bauart der Städtischen Strassenbahn Zürich.* F. Largiader. (107) Sept. 13.

Roads and Pavements.

Report of Committee on Service Tests of Flooring and Paving. (Am. Wood Preservers Assoc.) (113) Vol. 15.
The Value of Service Records for Wood-Block Paving.* Walter Buehler. (113) Vol. 15.
Report of Committee on Wood-Block Flooring and Paving. (Am. Wood Preservers Assoc.) (113) Vol. 15.
Smooth Concrete for Creosoted-Wood Paving.* Ellis R. Dutton. (113) Vol. 15.
Progress Report on Wood-Block Paving Experiments in Minneapolis.* C. H. Teesdale and J. D. MacLean. (113) Vol. 15.
The Task Confronting Highway Surveyors.* H. T. Chapman. (114) Aug. 2.
Recommended Practice of Mississippi Valley State Highway Departments for Concrete Road Construction. (96) Aug. 28.
Good Roads.* Chas. E. Puff. (2) Sept.
Overcoming Difficulties in Laying Concrete in Cramped Alleys.* W. W. Horner. (67) Sept.
Concrete Highway Construction Standards Raised. (Mississippi Valley Assoc. of State Highway Depts.) (67) Sept.
Resurfacing Old Macadam and Gravel Roadways with Special Reference to Adaptability of Old Roadbeds as Foundation for Hot Mix Bituminous Surfaces.* Hugh W. Skidmore. (60) Sept.
Experience with Granite Block Pavements in New Orleans, La. John C. Bartley. (60) Sept.
Recommended Procedure in the Construction of New Macadam Roads. M. D. Ross. (Paper read before Univ. of Kentucky Road School.) (60) Sept.
Estimating for Asphalt Pavement Repairs. J. O. Preston. (60) Sept.
Maintenance of Macadam and Gravel Roads. R. C. Heath. (From paper presented at the 1919 "Road Builders' Week" of the Univ. of Kentucky.) (86) Sept. 3.
Cost of Surveys for Federal Aid Roads Project in Kansas. (86) Sept. 3.
Methods of Protecting Concrete Pavements Laid in Warm Weather.* (Portland Cement Assoc.) (86) Sept. 3.
Progressive Method of Road Improvement for Rural Districts. Gabriel Henry. (From paper before Canadian Road Congress.) (86) Sept. 3.
Methods of Resurfacing Old Macadam. William N. Bosler. (From paper presented at the 1919 "Road Builders' Week" of the Univ. of Kentucky.) (86) Sept. 3.
New Stone and Gravel Roads Insured by Surface Treatment. F. H. Gilpin. (96) Sept. 4.
What Has New York State Received for Its $100 000 000 Highway Expenditures?* H. Eltinge Breed. (13) Sept. 4.
Corrugated Spacer Used for Wood-Block Pavements.* John S. Crandell. (13) Sept. 4.
Road Drainage and Foundations. Geo. Hogarth. (Paper read before Canadian Good Roads Assoc.) (96) Sept. 11; (86) Oct. 1.
Does Rich Concrete in Roads Crack More Than Lean? (13) Sept. 11.
Pneumatic Tools for Breaking Up Pavement.* Walter P. Burn. (17) Sept. 20.
New Features in Indiana's Concrete Road Specifications. (13) Sept. 25; (2) Oct.
Some Practical Points to Observe in the Construction of Bituminous Pavements. R. Keith Compton. (Paper read before League of Third Class Cities.) (60) Sept.; (86) Oct. 1.
The Roads of France.* G. A. Youngberg. (100) Sept.-Oct.
Macadam Construction on Primary and Secondary Feeder Highways. W. C. Buetow. (60) Oct.
The Construction of Portland Cement Concrete Pavement Foundations.* James W. Routh. (60) Oct.
Stone and Gravel Road Construction in Ontario. J. G. Wilson. (From paper read before Ontario Good Roads Assoc.) (60) Oct.
Recommended Procedure in the Design, Construction and Maintenance of Asphalt Macadam Pavements. Prevost Hubbard. (60) Oct.

* Illustrated.

Roads and Pavements—(Continued).

Impact Tests of Auto Trucks on Roads.* E. B. Smith and J. T. Pauls. (From Report of Bureau of Public Works.) **(86)** Oct. 1; **(13)** Sept. 18.
How to Secure Best Results in Construction of Improved Granite Block Pavements. Albert T. Rhodes. (From manual issued by Granite Paving Block Mfrs.' Assoc.) **(86)** Oct. 1.
Compact Portable Outfit for Testing Aggregates in the Field.* F. H. Jackson. (From *Public Roads.*) **(86)** Oct. 1.
The Economic Limit to Motor Truck Weights.* Robert C. Barnett. **(86)** Oct. 1.
Large Paving Mixer Puts in 180-Yard Slab Every Hour.* **(13)** Oct. 2.
Machines Take the Place of Men on 20-Mile Concrete Road.* **(13)** Oct. 2.
Is Beam Strength the Important Item in Brick Roads. Will P. Blair. **(13)** Oct. 9.
Mountain Highways at Hamilton, Ont. Noulan Cauhonk. (Excerpt from Report to City Council of Hamilton, Ont.) **(96)** Oct. 16.
Some Notes on English Highway Construction. H. T. Chapman. (From *The Surveyor.*) **(86)** Oct. 29.
Permanent Pavements at Railway Stations and Freight Terminals.* H. Colin Campbell. **(117)** Nov. 15.

Sanitation.

Problems of the State Department of Public Health During the War. H. P. Matte. **(59)** June.
The Utilization of Sewage Sludge.* John D. Watson. **(114)** Aug. 30.
Operating Experiences with Activated Sludge Process for Factory Wastes. George W. Fuller. **(60)** Sept.
The Trend in Municipal Refuse Collection and Disposal—Estimating Costs. Rudolph Hering. **(60)** Sept.
Sewage Disposal of Chicago.* C. D. Hill. **(117)** Sept. 1.
Sewage Disposal Difficulties at Madison, Wisconsin. **(13)** Sept. 11.
Tests of Lime-Electrolytic-Agitation Sewage-Treatment Process at Easton, Pennsylvania.* (From Reports of Pennsylvania State Dept. of Health and Franklin Inst.) **(13)** Sept. 18; **(96)** Oct. 16.
More Engineering on Sewer Inlets.* W. W. Horner. **(60)** Oct.
Drainage Culvert Built Through High Railway Fill. **(13)** Oct. 2.
Multiple Outlet Provides for Variable Sewage Flow.* S. T. Smetters. **(13)** Oct. 16.
Walkerville Underground Sewage-Pumping Plant.* Charles W. Tarr. **(96)** Oct. 30.
Building the Augusta Street Concrete Intercepting Sewer. W. T. Christine. **(117)** Nov. 1.
L'Industrie Moderne de l'Equarrissage. Francis Marre. **(33)** Aug. 23.
Ueber einige neuere praktische Verfahren zur Messung des Wärmeleitvermögens von Bau- und Isolierstoffen.* Max Jakob. **(48)** Serial beginning Jan. 25.

Structural.

Report of Committee on Preservatives. (Am. Wood Preservers Assoc.) **(113)** Vol. 15.
Report of Committee on Non-Pressure Treatments. (Am. Wood Preservers Assoc.) **(113)** Vol. 15.
Surface Tensions of Wood-Preserving Oils as Factors in Protection Against Marine Borers. L. F. Shackell. **(113)** Vol. 15.
Report of Committee on Plant Operation.* (Am. Wood Preservers Assoc.) **(113)** Vol. 15.
Calculating Diagrams for Reinforced Concrete.* James Williamson. **(12)** Aug. 15.
Establishing Standards in Construction.* A. B. Segur. **(86)** Aug. 27.
Specific Gravity as a Measure of Strength of Wood. (From *Bulletin* issued by U. S. Dept. of Agriculture.) **(86)** Aug. 27.
On the Rapid Seasoning of Jarrah.* Alfred Tomlinson. (Paper read before Western Australia Inst. of Engrs.) **(11)** Serial beginning Aug. 29.
Better Concrete—The Problem and Its Solution.* Nathan C. Johnson. **(2)** Sept.
Tests of Eighteen Concrete Columns Reinforced with Cast Iron. (U. S. Bureau of Standards.) **(3)** Sept.
Tests of Plain and Reinforced Gypsum Specimens. W. A. Slater. **(4)** Sept.
Run of 1 200 Yards in Twenty Hours Made with Conveyor System for Concrete Aggregates.* **(67)** Sept.
Ohio Hydrate & Supply Co.'s Plant.* **(67)** Sept.
Interesting Features of Dewey Cement Plant.* A. L. Frank. **(67)** Sept.
The Design and Equipment of the Wisconsin Sand and Gravel Company's Plant.* **(67)** Sept.
Fine-Grained Concrete Sands. F. E. Giesecke. **(96)** Sept. 4.

* Illustrated.

Structural—(Continued).

Paper Cylinders Used for Molds for Concrete Test Pieces.* Watson Davis. (13) Sept. 4.
Burnt Earth Concrete with Iron and Wood Reinforcement.* L. P. Hodge. (11) Sept. 5.
Handling Grain by the Boat-Load.* Rozel Gotthold. (Grain Elevator.) (46) Sept. 6.
"Compression" Wood and Failure of Factory Roof-Beam.* G. E. Heck. (13) Sept. 11.
Wind Pressure on Cylindrical Structures in Practice. R. Fleming. (13) Sept. 11.
Cost-Plus-Fee Contract. (Building Construction.) A. E. Wells. (96) Sept. 11; (96) Sept. 24.
Distribution of Concrete by Inclined Chutes.* (12) Serial beginning Sept. 12.
Deflection of Continuous Beams and Rigid Frames.* F. E. Richart. (13) Sept. 18.
Some Notes on Indeterminate Structures.* George Paaswell. (86) Sept. 24.
Significance of Cracks in Reinforced Concrete Construction. Stanley H. Harris. (From *Proceedings* of Royal Victorian Inst. of Architects.) (96) Sept. 25.
An Achievement in Foundry Design.* Gilbert L. Lacher. (20) Sept. 25.
Portland Grain Elevator Subsidence.* W. A. Scott. (117) Oct. 1.
Concrete I-Beams Used to Make Crib Retaining Wall.* (13) Oct. 2.
Wind Pressures and Wind Stresses in Tower Design.* R. Fleming. (13) Oct. 2.
Studies in Surface Area Proportioning Method.* Llewellyn N. Edwards. (96) Oct. 9.
Electric Hoists Pull 3 000-Ton Building 450 Feet.* (13) Oct. 9.
French Airship Sheds Built of Framed Concrete.* (13) Oct. 9.
Grain Silo at Hull.* (12) Oct. 10.
Excavation of N. Y.-N. J. Vehicular Tunnel.* J. F. Springer. (117) Oct. 15.
Common Errors in Detailing Steelwork for Buildings.* Edward Godfrey. (13) Oct. 16.
Concreting in Cold Weather. A. E. Wells. (86) Oct. 22; (96) Oct. 23.
Proper Methods of Applying Roofing on a Gypsum Roof Deck.* Curtis F. Columbia. (86) Oct. 22.
The Geology of Concrete Aggregates with Special Reference to Texture.* P. G. H. Boswell. (From *Concrete and Constructional Engineering.*) (86) Oct. 29.
Moulding Houses in Steel Form for War Workers.* Milton Dana Morrill. (67) Nov.
New York Vehicular Tunnel Lining.* J. F. Springer. (117) Nov. 1.
Macrographie des Aciers; Essai de Corrosion.* H. Le Chatelier and B. Bogitch. (93) Mar.
Le Séchage des Bois de Construction.* G. Malgorn. (33) Aug. 2.
Die Eisenpreise in England unter dem Kriege.* A. Argelander. (50) Feb. 21, 1918.
Stahlformguss als Konstruktionsmaterial.* Richard Krieger. (50) Serial beginning Apr. 25, 1918.
Entwicklung und Gegenwärtiger Stand des Stahlformgusses und seiner Herstellungsverfahren.* Carl Irresberger. (50) Apr. 25, 1918.
Untersuchung einer gerissen Schiffkesselplatte.* O. Bauer. (50) May 23, 1918.
Die Untersuchung der Metalle durch Röntgenstrahlen. Friedrich Janus. (50) Serial beginning June 6, 1918.
Ueber die Sicherung der Schweissnähte von Wasserkammern.* Friedrich Münzinger. (50) Aug. 8, 1918.
Ueber den elastischen Verdrehungswinkel eines Stabes. A. Föppl. (50) Serial beginning Aug. 22, 1918.
Die Grundlagen der Röntgenphysik in ihre Anwendung auf die Metalldurchstrahlung.* G. Respondek. (50) Serial beginning Sept. 12, 1918.
Ueber den derzeitigen Stand unserer Erkenntnisse hinsichtlich der Elastizität und Festigkeit von Gusseisen. E. Leber. (50) Sept. 26, 1918.
Beitrag zur Entstehung des Holzfaser- und Schieferbruchs.* Reinhold Kühnel. (50) Dec. 19, 1918.
Ueber feuerfeste Baustoffe, insbersondere Silikasteine.* Hugo Krueger. (50) Dec. 26, 1918.
Ueber einige neuere praktische Verfahren zur Messung des Wärmeleitvermögens von Bau- und Isolierstoffen.* Max Jakob. (48) Serial beginning Jan. 25.
Beton aus Hochofenschlacke. (50) Feb. 13.
Rostsicherheit verzinkter Bleche.* Max Schlötter. (50) Mar. 6.
Beiträge zur Kenntnis der Spannungen im Grauguss unter Zugrundelegung verschiedener Gattierungen. Otto Banse. (50) Serial beginning Mar. 27.
Zugspannungen des Betons im Eisenbetonbau.* O. Leuprecht. (107) June 7.
Die neue Schlachthofanlage in Liestal.* W. Brodtbeck. (107) Aug. 2.
Die selektiven Korrosionen; die Bedingungen ihres Entstehens und die Mittel, sie zu verhüten. F. v. Wurstemberger. (107) Serial beginning Aug. 9.
Graphische Tabelle zur Dimensionierung einfach armierter Eisenbeton-Platten für n=20. R. Forter. (107) Aug. 30.

* Illustrated.

Topographical.

Cost of Surveys for Federal Aid Roads in Kansas. **(86)** Sept. 3.
Surveying and Mapping from Airplanes. E. Lester Jones. (From paper read before Second Pan-Am. Aeronautic Convention.) **(86)** Sept. 17.
Sextant and Stadia-Rod Method for Measuring Distance. B. A. Bird. **(13)** Oct. 2.

Water Supply.

Water Treatment at Council Grove, Kansas.* Louis L. Tribus. **(59)** Dec., 1918.
Lead Pipe Couplings. J. A. Jensen. **(59)** Dec., 1918.
Office Records of the St. Louis Water Division, Distribution Section. Thomas E Flaherty. **(59)** Dec., 1918.
Reinforced Concrete Pressure Pipe.* Coleman Meriwether. **(59)** Dec., 1918.
Significance of Black Sands in Filters.* J. E. Welker and C. C. Young. **(59)** Dec., 1918.
Memoranda of Office Records.* A. W. Cuddeback. (Passaic Water Co.) **(59)** Dec., 1918.
The Properties of Certain Waters with Reference to Their Action on Metals. S. W. Parr. **(59)** Dec., 1918.
Economical Size of Pipe for Given Loss of Head.* E. W. Rettger **(36)** April.
The Trenton, N. J., Filtration Plant.* F. W. Daggett. **(59)** June.
Settling Basin Efficiency at Philadelphia.* Joseph S. V. Siddons. **(59)** June.
Some Observations and Experiences in the Operation of Coagulating Basins.* James W. Armstrong. **(59)** June.
Cost of Pumping Through Pipe Lines.* G. C. Habermeyer. **(59)** June.
New Well of Large Capacity at the University of Illinois.* M. L. Enger. **(59)** June.
Unusual Ground Water Supply Conditions at Baton Rouge, Louisiana. L. R. Howson. **(59)** June.
Water Testing Stations. W. T. McClenahan and R. S. Rankin. **(59)** June.
The Operation of the Moline Filtration Plant. A. E. Anderson. **(59)** June.
Typhoid Fever at Moline, Illinois. M. C. Sjoblom. **(59)** June.
The Lime-Softening of Water and the Use of the Sludges as an Aid Thereto.* W. A. Sperry. **(59)** June.
Water Softening for Municipalities.* Milton F. Stein. **(59)** June.
Chloramine and Crenothrix.* W. F. Monfort and O. A. Barnes. **(59)** June.
Notes on Utility and Performance of Compound Meters.* Fred B. Nelson. **(59)** June.
Water Expectancy in Tunnels, Mines and Deep Wells in Homogeneous Rocks. Robert E. Horton. **(59)** June.
The Operation of Cantonment Water-Works.* G. A. Johnson. **(59)** June.
Quality of Water in Illinois Streams. Minna E. Jewell. **(59)** June.
Design of a Tilting Dam and Its Relation to Backwater on the Gunpowder River.* V. Bernard Siems. **(59)** June.
The Relation of Depreciation to Investment. W. C. Hawley. **(59)** June.
Progress of Queenston-Chippawa Power Canal.* **(96)** Aug. 28.
Atmospheric Pollution from the Engineer's Standpoint and Its Water Impurities.* John B. C. Kershaw. **(12)** Aug. 29.
The Design and Construction of Reinforced Concrete Covered Reservoirs.* R. DeL. French. **(5)** Sept.
Methods Used and Results Obtained in Metering the Water Supply of Terre Haute, Ind.* Dow R. Gwinn. **(60)** Sept.
The Ipswich River Water Supply for the City of Lynn, Mass.* H. K. Barrows. **(60)** Sept.
Some Economies That May Be Effected in the Operation and Maintenance of the Water Works System.* Homer V. Knouse. (Paper read before Southwestern Water Works Assoc.) **(60)** Sept.; **(86)** Oct. 8.
Water-Shed Leakage in Relation to Gravity Water Supplies.* Robert E. Horton. **(28)** Sept.
Dangerous Reduction of Insulation Resistance in High-Pressure Fire-Service Motors, Due to Moisture. Wm. W. Brush. **(28)** Sept.
Protecting Iron and Steel Standpipes from Corrosion.* Charles W. Sherman. **(28)** Sept.
Some Details of Water-Waste Prevention Surveys.* Paul Lanham. **(28)** Sept.
Schoharie Development, Catskill Water Supply System for New York City.* J. Waldo Smith. **(28)** Sept.
The New Ten-Million-Gallon Reservoir of the City of Dayton, Ohio.* Leonard Metcalf and William T. Barnes. **(28)** Sept.
Development of the Gatun Hydroelectric Station.* **(111)** Sept. 1.
Waste Water Control. E. D. Case. (Paper read before Southwestern Water Works Assoc.) **(117)** Sept. 1.
Operation Methods and Results on the Lindsay-Strathmore Irrigation District.* E. Court Eaton. **(13)** Sept. 4.

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* Illustrated.

Water Supply – (Continued).

Diagram for Computing Band Spacing for Wood-Stave Pipe.* Willis T. Batcheller. (13) Sept. 4.
Old Diamond-Drill Hole as Cableway for New Churn-Drill Hole.* Roy H. Poston. (16) Sept. 6.
Points to be Considered in Reconstruction of Small Water Power Plants. R. K. Holland. (Abstract of a paper read before Michigan Eng. Soc.) (86) Sept. 10.
Construction Features of Grand River Roller Crest Dam. O. J. Reedy. (From *Reclamation Record.*) (117) Sept. 1; (86) Sept. 10.
New Water Filtration Plant of Whiting, Indiana.* Renville S. Rankin. (86) Sept. 10.
Stream Flow and Percolation Water.* Samuel Hall. (Paper read before Inst. of Water Engrs. of Great Britain.) (96) Serial beginning Sept. 11.
Reconstruction of Water Works at Cobourg, Ont.* A. E. Davison. (96) Sept. 11.
The McClure Hydro-Electric Plant.* (16) Sept. 13.
Kipawa Co.'s Pulp Mill and Power Development.* (96) Sept. 18.
Operation of Slow Sand Filters at Toronto.* Norman J. Howard. (96) Sept. 18.
Drainage Works of the Rio Grande Irrigation Project.* J. L. Burkholder. (13) Sept. 18.
Method of Constructing a Diagram to Show Probable Droughts.* U. T. Tchikoff. (13) Sept. 18.
Groined Arches or Flat Roof for Concrete Reservoirs. (13) Sept. 18.
Making the Desert Bloom in Australia.* Oliver Johnson. (46) Sept. 20.
Constructing a 98-Kilometer Water Conduit in Chile.* George H. Bayles. (13) Sept. 25.
Purification-Plant Methods and Results at Albany.* (13) Sept. 25.
Computation of the Coefficient of Discharge of Venturi Meters.* W. S. Pardoe. (13) Sept. 25.
Permanent Plants for Chloramine Installed at Denver.* (13) Sept. 25.
Water Departments and Private Fire Lines. Dow R. Gwinn. (Abstract of paper read before Indiana Sanitary and Water Supply Assoc.) (96) Sept. 25.
The Economical Design of Water Conduits.* W. T. Taylor. (12) Sept. 26.
How to Reconstruct Small Water Power Plants. Ray K. Holland. (Paper read before Michigan Eng. Soc.) (60) Oct.
Hydroelectric Development on Wisconsin River at Stevens Point.* William F. Snyder. (117) Oct. 1.
Operation of Drifting Sand Filters at Toronto.* Norman J. Howard. (96) Oct. 2.
Another Diagram for Solving the Manning Hydraulic Formula.* R. D. Goodrich. (13) Oct. 2.
Concreting Procedure on Miami Flood-Control Dams.* (13) Oct. 2.
Solving Hydro-Electric Problems of a Small Town.* (13) Oct. 2.
Notes on Filtration Plant Operations at St. Louis.* Edward E. Wall. (From report to City of St. Louis.) (86) Oct. 8.
Cost of Engineering Work for Maintenance and Operation of Large Irrigation Project.* H. M. Chadwick. (86) Oct. 8.
Backfilling the Red River Tunnel.* J. Armstrong. (96) Oct. 9.
World's Largest Dam. (117) Oct. 15.
Hydroelectric Power Development in British Empire. (117) Oct. 15.
The Yarhola Pipe Line.* Wynn Meredith. (117) Oct. 15.
Greater Winnipeg New Water Supply. (12) Oct. 24.
New Type of Lime and Soda Softening Plant for Water Purification.* (From *The Surveyor.*) (86) Oct. 29.
Stream Flow and Percolation Water.* Samuel Hall. (From *Journal* of Inst. of Water Engrs. of Great Britain.) (86) Oct. 29.
New Hydro-Electric Developments at Niagara.* (12) Serial beginning Oct. 31.
Hydroelectric Installations in Norway.* Chas. H. Tallant. (111) Nov. 1.
The Toronto Drifting Sand Water Purification Plant.* William Gore and William Storrie. (5) Nov.
Queenston-Chippawa Development at Niagara Falls, Ontario.* Harry Gardiner. (117) Nov. 1.
Effect of Water Uplift on Overturning of Dams.* Erwin Maerke. (96) Nov. 6.
Hydro-Electric Power Development at High Falls.* (96) Nov. 13.
Electrically Operated Wasteways of the Tieton Canal.* C. F. Gleason. (111) Nov. 15.
Measurement of Pressures in Core of Hydraulic Fill Dam.* (From Miami Conservancy *Bulletin.*) (86) Nov. 19.
Earth Slides in Winnepeg Aqueduct Construction.* Douglas L. McLean. (96) Nov. 20.

Waterways.

Long Wharf of Southern Pacific Company at Oakland, Cal. F. D. Mattos. (113) Vol. 15.

* Illustrated.

Waterways—(Continued).

Inland Waterway Transportation. Theodore Brent. (4) June.
The Jersey Central is Building a Modern Coal Pier.* (15) Aug. 29.
Notes on the Inland Waterways of France.* L. E. Lyon. (100) Sept.–Oct.
Concrete Wall Construction is Continuous Process. (13) Sept. 4.
Board Mattress for Preventing Scour in Drainage Channel.* B. F. Burns. (86) Sept. 10.
Creek Control at Kingston, W. Va.* Walter H. Dunlap. (45) Sept. 11.
Widened Channel Reduces Flood Hazard at Columbus.* (13) Sept. 11.
Semi-Portal Dock Cranes at Boston Army Base Wharf.* (13) Sept. 11.
Some River Control Work of the C., B. & Q.* (18) Sept. 13.
Freight Handling at the Brooklyn Army Base.* (13) Sept. 18.
The Self-Sinking Concrete Pile.* (46) Sept. 20.
Extending the Galveston Sea Wall.* J. B. Lippincott. (13) Sept. 25.
Chaining the Missouri.* H. T. Dobbins. (46) Sept. 27.
World's Largest Marine Terminal.* Zanas W. Carter. (117) Oct. 1.
Pile Foundations for Unequal Load Distribution.* Edwin P. Arneson. (13) Oct. 9.
Proposed Plans for the All-American Canal.* (111) Oct. 15.
The Coal Harbour of New York.* J. T. Springer. (57) Oct. 17.
Sand Sluicing of Canals.* H. M. Schilling. (117) Nov. 1.
Discharge Coefficients for Canal Head Gates.* J. S. Longwell and Julian Hinds. (117) Nov. 1.
Making Interlocking Steel Piling Watertight.* W. T. Christine. (117) Nov. 15.
Les Dragues Flottantes à Pelle americaines.* Geo. B. Massey. (33) Aug. 2.
L'Aménagement du Rhône à l'Aide de Barrages Successifs.* L. Mähl. (33) Aug. 23.
Rutsch-Erscheinungen beim Absenken des Ritom-See.* Hans Roth. (107) Aug. 2.

* Illustrated.

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INDEX

"A Plea for Broader Technical Education." Extract from Article by Mortimer E. Cooley on, 469.

ABEL, ARTHUR HENRY.—Elected an Associate Member, 410.

Accessions to Engineering Societies Library, 43, 221, 330, 437, 507, 729, 833, 992.

Accessions to Reading Room of Society, 509, 999.

ACHER, ALBERT HILANDS.—Transferred to Grade of Member, 882.

ACKER, LAMAR.—Elected an Associate Member, 118.

ADAMS, ARTHUR.—Discussion by, 536.

ADAMS, COMFORT A.—Address by, 420.

Advisory Engineering Committee of State of New York.—Appointment of, 311.

AERTSEN, G.—Appointed to Represent Society at Meeting of American Institute of Mining Engineers, 127.

ALBERT, FREDERICK WILHELM.—Transferred to Grade of Member, 119.

Alfred Noble Memorial.—Report to Board of Direction Relative to Removal of Model of, 466.

Alfred Noble Memorial, Committee on.—Progress Report of, 117, 140.

ALLEN, HERMON CHARLES.—Death announced, 538.

ALLEN, KENNETH.—Discussion by, 1.

ALLIN, RAY LESTER.—Transferred to Grade of Associate Member, 882.

ALLING, ARTHUR RICH.—Elected an Associate Member, 536.

ALTHOUSE, IRVIN HENRY.—Elected an Associate Member, 879.

ALVORD, JOHN W.—Elected a Director, 122, 149; Letter from J. A. Ockerson Relative to Eligibility of, For Election as Director, 126; On Committee on Special Committees, 129; Discussion by, 541, 556; On Committee of Board of Direction to Review Report of Committee on Development, 885.

American Association for the Advancement of Science.—Notice of Meeting of, 954.

American Association of Engineers.—Letter from Chairman of Engineering Council Relative to Work of, 933.

American Concrete Pipe Association.—Invitation from, To Appoint Representatives of Society on Joint Committee on Culvert Pipe Specifications, 883, 934; Annual Convention of, 957.

American Engineering Delegates to Joint Engineering Congress, Paris, 1918.—Report to Board of Direction Relative to Appointment of, By Executive Committee, 125; Action of Board of Direction Relative to Resolutions of Duluth Association on Appointment of, 125, 198; Addresses by, 172; Report of, 604.

American Engineering Standards Committee.—Letter from J. Martin Schreiber to Board of Direction Relative to Work of, and Appropriation for, 126; Resignation of John H. Gregory as Member of, 126; Report of Committee of Board of Direction Relative to Representatives of Society on, 127; Tentative Standard Tests Adopted by, 425; Report to Board of Direction Relative to Acceptance by H. J. Burt of Appointment as a Representative of Society on, 464; Report to, and Action by, Board of Direction on Proposed Changes in Constitution of, 884; Resolution of Founder Societies Finance Committee on Appropriation for Work of, 884; Resolutions of, Relative to Conference on Standardization of Screw Threads, 952.

AMERICAN

American Expeditionary Forces, Engineer Department of.—Work of, In France, 809.
American Federation of Labor.—Resolution by, Relative to Labor and Scientific Research, 696; Letter from President of, 878.
American Highway Congress, 1st.—Announcement Relative to Meeting of, 9.
"American Highways," Informal Discussion on, 459.
American Independence Room, Versailles, France.—Statement Relative to, 962.
American Institute of Consulting Engineers.—Letter to President Wilson from Council of, Criticizing the Plumb Plan for Railroads, 803.
American Institute of Electrical Engineers.—Representatives of, On Founder Societies' Finance Committee on Joint Activities, 684; Award of Edison Medal of, 690; Representatives of, On Permanent Franco-American Engineering Committee, 938.
American Institute of Mining and Metallurgical Engineers.—Appointment of Representatives of Society at Meeting of, 127; Change in Name of, 311; Representatives of, On Founder Societies' Finance Committee on Joint Activities, 684; Representatives of, On Permanent Franco-American Engineering Committee, 938; Dinner by, To Herbert Clark Hoover, 954.
American Institute of Mining Engineers. *See* American Institute of Mining and Metallurgical Engineers.
American Machinist.—Advertisement from, Relative to Present Conditions, 489.
American Railroad Association.—Reorganization of, 489.
American Railway Engineering Association.—Appointment Suggested of Temporary Committee to Confer with, Relative to Adoption of New Column Formula, and Train Loadings, 290; Appointment of Committee to Confer with Committee on Iron and Steel Structures of, 468.
American Society for Testing Materials.—Annual Meeting of, Announced, 488.
American Society of Civil Engineers.—Progress Report of Committee on Development of, 117, 140, 540, 545, 551, 589, 889; Action of Board of Direction Relative to Resolutions of Duluth Association and Other Local Associations on Committee on Development of, 125, 200; Letter to Board of Direction of, From Engineering Institute of Canada, Extending Greetings, 127; Letters to Governors of States by, Relative to Engineering Societies Employment Bureau, 302; Membership of, Passes 9 000 Mark, 425; Approval by Board of Direction of Action of Executive Committee Relative to Progress Report of the Committee on Development of, For Presentation to Annual Convention, 464; Appropriation by Board of Direction for Work of Committee on Development of, 466; Resolutions of Cleveland Association Relative to Work of Committee on Development of, 318, 467; Action of Board of Direction Relative to Resolutions of Cleveland Association on Work of Committee on Development of, 467; Resolution of Board of Direction Expressing Confidence in Work of Committee on Development of, 467; Message from Board of Direction Relative to Work of Committee on Development of, 467; Action by Southern California Association Relative to Work of Committee on Development of, 325, 467; Report to, and Action by, Board of Direction Relative to Action of Southern California Association on Work of Committee on Development of, 467; Discussion of Report of Committee on Development of, 541, 552, 878; Report of Committee on Special Committees on Work of Committee on Development of, 545, 685;

AMERICAN

Resolution of Board of Direction Relative to Presentation and Distribution of Progress Report of Committee on Development of, 545; Resolution of Board of Direction Authorizing Additional Meeting of Committee on Development of, 545; Statement to, and Action by, Board of Direction Relative to Request to Add Explanatory Matter to Progress Report of Committee on Development of, 545; Resolution of Board of Direction Authorizing Addition of Explanatory Matter to Progress Report of Committee on Development of, 545; Resolution of Board of Direction Requesting Onward Bates to Continue as Chairman of Committee on Development of, 545; Announcement of September, 1919, Meeting of Committee on Development of, 799; Appointment of Daniel Bontecou as Member of Committee on Development of, Approved, 883; Resignation of C. M. Holland as Member of Committee on Development of, Accepted, 883; Resignation of Onward Bates as Chairman and Member of Committee on Development of, 884; Representatives of, On Permanent Franco-American Engineering Committee, 884, 938; Report, with Letters, of Committee on Development of, Presented to Board of Direction, 884; Appointment of Sub-Committee on Budget by Committee on Development of, 884; Resolution of Board of Direction on Report of, Committee on Development of, 885; Discharge of Committee on Development of, 885; Appointment of Committeee of Board of Direction to Review Report of Committee on Development of, 885; Letters Relative to Report of Committee on Development of, 920.

American Society of Mechanical Engineers.—Representatives of, On Founder Societies' Finance Committee on Joint Activities, 684; Representatives of, On Permanent Franco-American Engineering Committee, 938.

American Welding Society.—Appointment of Robert A. Cummings as Representative of Society on Board of Directors of, 492, 546.

Anderson, Andrew Elliott.—Elected an Associate Member, 118.

Anderson, Bjarne Bergsland.—Elected a Junior, 875.

Anderson, Charles Irving.—Elected a Member, 118.

Anderson, Edward Stewart.—Elected a Member, 118.

Anderson, George A.—Discussion by, 541, 568.

Anderson, Robert Sumter.—Transferred to Grade of Associate Member, 412.

Anderson, Victor Franklin.—Elected a Junior, 870.

Announcements, 14, 203, 313, 429, 495, 707, 822, 972.

Annual Convention, 49th.—Time and Place Announced, 129, 313; Appointment of Committee of Arrangements for, 129, 429, 495; Minutes of Meetings of, 540, 548, 550; Excursions and Entertainments at, 575; Attendance at, 577.

Annual Convention, 50th.—Appointment of Chairman of Local Committee of Arrangements of, 887.

Annual Meeting.—Minutes of, 115, 131; Excursions and Entertainments at, 151; Attendance at, 151; Committee of Arrangements for, 887, 972.

Ansell, S. T.—Address by, 151, 292.

Appropriations for Government Engineering Work, 688.

Arabian Railway, New.—Statement Relative to, 957.

Archer, Augustus Rowley.—Transferred to Grade of Member, 871; Resolution by, On Relation of the Engineer to the Future Military Activities of the United States, 873.

Archer, William.—Death announced, 882.

Armstrong, W. C.—On Local Committee of Arrangements for Annual Convention, 429, 495.

ARMY

Army Personnel Work.—Statement Relative to Exhibit of, 310.
ARNESON, EDWIN PERCIVAL.—Elected an Associate Member, 536.
ARNOLD, FRANK PALMER.—Elected a Junior, 870.
ARNOLD, LEROY.—Elected an Associate Member, 118.
ASH, WILLIAM JOHN.—Elected an Associate Member, 879.
ASHMEAD, PERCY HERBERT.—Death announced, 878.
Associated General Contractors of America.—Statement Relative to Organization of, 9.
Association of Members of American National Engineering Societies in Cuba.—Organization Announced, 490.
Atlanta Association.—Abstract of Minutes of Meetings of, 205.
ATWATER, ALBERT WORTHINGTON.—Elected an Associate Member, 868.
AUSTIN, HERBERT SIDNEY.—Elected an Associate Member, 410.
Automobile Shows of 1920.—Notice of, 949.
AYER, JOHN.—Transferred to Grade of Member, 119.
AYERS, AUGUSTINE HAINES.—Transferred to Grade of Member, 461.

BABB, CHARLES STEWART.—Elected an Associate Member, 410.
BABBITT, HENRY KEEPERS.—Elected a Member, 410.
BACHMAN, HOWARD FINK.—Elected an Associate Member, 879.
BADT, ROY ARIN.—Elected an Associate Member, 536.
BAER, BERNARD EDWARD.—Elected a Junior, 411.
BAILHACHE, JOHN GOODIN.—Transferred to Grade of Associate Member, 876.
BAILLIE, FRANK SEYMOUR.—Elected a Member, 536.
BAKER, HOLLAND WILLIAMS.—Death announced, 290.
BAKER, SYLVESTER CLAY.—Elected an Associate Member, 868.
BAKER, WILLIAM DARTIS.—Elected an Associate Member, 868.
BALDWIN, A. S.—Appointed to Represent Society at Conference to Consider Establishment of National Department of Public Works, 464, 492.
BALL, WENDELL PHILIP.—Elected an Associate Member, 118.
BALLEISEN, LEOPOLD LYON.—Elected a Junior, 870.
BAME, ROBERT WILLIAM.—Elected an Associate Member, 868.
BARKER, EDGAR EARL.—Elected an Associate Member, 868.
BARNARD, W. K.—On Nominating Committee, 116, 128, 134.
BARNES, HENRY WILFRID.—Transferred to Grade of Associate Member, 876.
BARNES, WARREN HAMMOND.—Elected a Member, 868.
BARRETT, PETER THORNTON.—Elected an Associate Member, 541.
BARRETT, ROBERT EDWARD.—Transferred to Grade of Member, 543.
BARTHOLOMEW, HARLAND.—Elected an Associate Member, 873.
BARTOCCINI, ASTOLFO.—Transferred to Grade of Member, 461.
BASS, F. H.—On Local Committee of Arrangements for Annual Convention, 429, 495.
BATES, GEORGE WHITNEY.—Elected an Associate Member, 541.
BATES, ONWARD.—Discussion by, 541, 552; Presents Progress Report of Committee on Development, 545; Requests Privilege of Adding Explanatory Matter to Report of Committee on Development, 545; Resolution of Board of Direction Requesting Continuance of, As Chairman of Committee on Development, 545; Resignation of, As Chairman and Member of Committee on Development Accepted, 884; Letter from, Relative to Report of Committee on Development, 884.
BAYER, HARRY LEWIS.—Elected a Junior, 543.
BAXTER, WARREN GAMMELL.—Elected an Associate Member, 879.
BEAHAN, WILLARD.—Elected a Director, 122, 149; On Library Committee, 129.
BEAN, PAUL JONES.—Death anannounced, 463.

BEANFIELD

Beanfield, Rufus McClellan.—Elected an Associate Member, 410.
Beckett, Garner Arthur.—Elected an Associate Member, 879.
Beer, Frederick Max.—Elected an Associate Member, 541.
Behneman, Stanley Elgin Clinton.—Elected an Associate Member, 873.
Beilharz, William Earnest.—Elected an Associate Member, 118.
Belden, George Allyne.—Transferred to Grade of Associate Member, 876.
Belgium. — Exhibition to Revive Agriculture in, 957; Reconstruction Work in, 958; Town Planning in, 960; Industrial Information Relative to, 962.
Belknap, W. E.—Discussion by, 539.
Bell, Alonzo Clarence.—Death announced, 2.
Bell, Harold Sill.—Elected an Associate Member, 874.
Bell, Henry Walton.—Transferred to Grade of Member, 876.
Bell, Victor Hugo.—Death announced, 123.
Bement, R. B. C.—On Local Committee of Arrangements for Annual Convention, 429, 495.
Bengel, George Adam.—Elected an Associate Member. 541.
Bennett, J. W. F.—Appointed Teller to Canvass Ballot for Officers, 115, 131, 150.
Bensel, John A.—Discussion by, 868.
Berdeau, Ray William.—Transferred to Grade of Associate Member, 120.
Berents, Hans.—Transferred to Grade of Member, 876.
Berger. Bernt.—Death announced, 123.
Bernhard, J. H.—Discussion by, 122.
Bernstein, Leo Harry.—Elected an Associate Member, 868.
Berthe, Lucius Tullius.—Transferred to Grade of Member, 119.
Bertin, Réne Leon.—Elected a Member, 868.
Besler, W. G.—Discussion by, 878.
Betaque, Harry Andrew.—Elected an Associate Member, 868.

BETTS

Betts, Clifford Aull.—Transferred to Grade of Associate Member, 538.
Beuttenmuller, Rudolf William.—Elected an Associate Member, 460.
Beyer, Theodore Alexander.—Elected a Member, 118.
Bilyeu, Charles S.—Discussion by, 879.
Bingham, Don William.—Elected an Associate Member, 868.
Bird, Harold Crusius.—Transferred to Grade of Associate Member, 538.
Bishop, Lyman Edgar.—Transferred to Grade of Member, 543.
Bissell, Charles Arthur.—Elected an Associate Member, 541.
Bixby, Frederick Louis.—Transferred to Grade of Member, 411.
Black, Frank Laughton.—Elected a Member. 873.
Black, Joel Hoffman.—Elected an Associate Member, 869.
Black, Roger Derby.—Discussion by, 868; Transferred to Grade of Member, 871.
Black, William Murray.—Discussion by, 873; Retires from Active Service as Chief of Engineers, U. S. A., 939.
Blackburn, Thomas Brogden.—Elected a Member, 873.
Blackwell, James Eustace.—Elected a Member, 868.
Blair, Walter D.—Discussion by, 867.
Blakeslee, Clarence.—Discussion by, 541, 560.
Blakeslee, Harold Law.—Transferred to Grade of Associate Member, 462.
Blaser, A. F.—Discussion by, 541, 565.
Bleistein, Bernard Joseph.—Transferred to Grade of Associate Member, 876.
Bley, Charles Nicholas.—Elected an Associate Member, 536.
Blum, Bernard.—Elected a Member, 873.
Blundon, Joseph Paul.—Elected a Junior, 875.
Blyth, Alexander Watt.—Elected an Associate Member, 541.
Board of Direction.—Report of, 27, 116, 124, 131; Resolutions by,

BOARD

Relative to Dismissal of Engineering Employees of Public Service Commission, 117, 128, 141, 142; Minutes of Meetings of, 123, 128, 129, 291, 463, 465, 468, 544, 546, 883, 888; Statement to, By Finance Committee, 123, 129; Report to, Of Resolutions Adopted by Library Board of United Engineering Society Relative to Recataloguing Engineering Societies Library, 123; Resolution by, Relative to Recataloguing of Engineering Societies Library, 124; Action by, Relative to Recommendation to Reduce Cost of 1919 Year Book, 124; Adoption by, Of Annual Report, 124; Approval by, of Minutes of Meetings of Executive Committee of, 124, 883; Report to, and Action by, Relative to Reports of Committee on Setting and Judging Engineering Problems, 124; Reports to, and Action by, On Establishment of Student Branches of the Society, 124; Report to, Of Committee on Special Committees, 125, 545, 685; Appointment by, Of Representatives of Society on Engineering Council, 125; Adoption by, Of Resolutions Relative to Extension of Mortgage on Society House, 125; Report to, Relative to Alteration of Society House, 125; Report to, Relative to Appointment by Executive Committee, Of Delegates to Joint Engineering Congress in Paris, 125; Action by, Relative to Resolutions of Duluth Association on Appointment of Delegates to Joint Engineering Congress in Paris, 125, 198; Action by, Relative to Resolutions of Duluth Association and Other Associations on Committee on Development, 125, 200; Resolution by, Relative to Eligibility to Election as Member of, 126; Action by, Relative to Request of Engineering Council for Appropriation for Work of National Service Committee, 126; Action by, Relative to Work of, and Appropriation for, American Engineering Standards Committee, 126; Acceptance by, Of Resignation of John H. Gregory as Member of American Engineering Standards Committee, 126; Appointment by, Of Henry Jackson Burt as Representative of Society on American Engineering Standards Committee, 127; Adoption by, Of Recommendation of Committee Appointed to Report on Representatives of Society on American Engineering Standards Committee, 127; Adoption by, Of Report of Committee to Recommend the Award of Prizes, 127; Report to, On Acceptance by J. V. Davies of Re-election as Representative of Society in United Engineering Society, 127; Greetings to, From Engineering Institute of Canada, 127; Appointment by, Of Representatives of Society at Meeting of Society for Promotion of Engineering Education, 127; Appointment by, Of Representative of Society on Washington Commission of Award, 127; Authorization by, Of Appointment of Representatives of Society at Meeting of American Institute of Mining Engineers, 127; Report to, and Action by, Relative to Committee on Technical Symbols, 127; Action by, Relative to Report of Tellers Appointed to Canvass Final Suggestions for Nominating Committee, 128; Report to, Relative to Disposal of Copies of Papers of 1904 International Engineering Congress, 128; Communication to, From Brooklyn Engineers Club Relative to Dismissal of Engineering Employees of Public Service Commission, 128; Action by, Relative to Dismissal of Engineering Employees of Public Service Commission, 129; Secretary Elected by, 129; Adoption by, Of 1919 Budget, 129; Appointment by, Of Standing Committees of, 129; Action by, Relative to 1919 Annual Convention, 129; Authorization by, Of Appointment of Committee of Arrangements for Annual Convention, 129; Action by, Relative

BOARD

BOARD

to Collations at Society Meetings, 129; Statement to, Relative to Work of Office, 130; Resolution by, Relative to Appointment of Committee to Consider the Question of the Assistant Secretary, 130; Report to, Relative to Changes of Style in Year Book and *Proceedings*, 463; Authorization by, Of Letter-Ballot on Changes in Style of Year Book and *Proceedings*, 463; Approval by, Of Action of Executive Committee Relative to Progress Report of the Committee on Development for Presentation to Annual Convention, 464; Report to, Relative to Election of Stephen L. Coles as Assistant Secretary and the Retirement of Thomas J. McMinn, Assistant Secretary, 464; Report to, Of Appointment by Executive Committee, of A. S. Baldwin to Represent Society at Conference to Consider Establishment of National Department of Public Works, 464, 492; Presentation to, Of Prospectus of Work of National Service Committee, 464; Resolution by, Approving Work of National Service Committee as Presented in Prospectus, 464; Report to, Of Acceptance by J. R. Worcester and A. N. Talbot of Appointment as Representatives of Society on Engineering Council, 464; Report to, Of Acceptance by H. J. Burt of Appointment as Representative of Society on American Engineering Standards Committee, 414; Resolutions by, Relative to the Proposed Purchase of Additional Real Estate by United Engineering Society, 465; Authorization by, Of Appointment of Representatives of Society on Engineering Division of National Research Council, 466, 492; Action by, Relative to Resolutions Adopted by Kansas City Engineering Society, Ohio Engineering Society, and Rochester Engineering Society on Development of Professional Engineering, 466; Appropriation by, For Work of

BOARD

Committee on Development, 466; Report to, Relative to Removal of Model of Alfred Noble Memorial, 466; Resolutions of Engineering Council and St. Louis Association Relative to Additional Contributions for Work of National Service Committee, Considered, 466; Resolutions of, Relative to Request for Additional Contribution for Work of National Service Committee, 466; Action by, Relative to Resolutions of Cleveland Association on Work of Committee on Development, 467; Resolution by, Of Confidence in Work of Committee on Development, 467; Message of, Expressing Sympathy, etc., with Work of Committee on Development, 467; Report to, and Action by, Relative to Action by Southern California Association on Work of Committee on Development, 467; Report to, and Action by, Relative to Action of Duluth Association Recommending Adoption by Engineering Council of News Bulletin, 467; Authorization by, Of Appointment of Committee to Recommend the Award of Prizes, 468; Appointment by, Of Committee to Confer with Committee on Iron and Steel Structures of American Railway Engineering Association, 468; Report to, Of Result of Ballot on Proposed Changes in Year Book and *Proceedings*, 540, 550; Report to, From Finance Committee, Relative to Increase in Employees' Salaries, 544, 681; Approval by, Of Recommendation by Finance Committee, Of Appropriation for Re-Cataloguing Engineering Societies Library, 544, 681; Report to, From Library Committee, On Engineering Societies Library, 544, 683; Resolution by, Relative to Ownership of Books in Engineering Societies Library, 544; Report to, From Publication Committee, 545; Report to, and Action by, On Result of Ballot on Changes in

BOARD

Year Book and *Proceedings*, 545; Invitation by, to Past-President Onward Bates to Present Progress Report of Committee on Development, 545; Resolution by, Relative to Presentation and Distribution of Progress Report of Committee on Development, 545; Resolution by, Authorizing Additional Meeting of Committee on Development, 545; Statement to, and Action by, Relative to Request to Add Explanatory Matter to Report of Committee on Development, 545; Resolution by, Authorizing Addition of Explanatory Matter to Report of Committee on Development, 545; Resolution by, Requesting Onward Bates to Continue as Chairman of Committee on Development, 545; Report to, Of Committee on Formation of Franco-American Engineering Committee, 546; Report to, Of Acceptances of Appointment of Representatives on Engineering Division, National Research Council, American Welding Society, and Committee to Recommend the Award of Prizes, 546; Appointment by, Of Francis R. Weller to Represent Society at Conference on Business Training for Engineers, etc., 546; Presentation to, Of Resolution Recommending Appointment of Founder Societies' Finance Committee on Joint Activities, 546; Appointment by, of Representatives of Society on Founder Societies' Finance Committee on Joint Activities, 546; Authorization by, Of Appropriation for Use of Engineering Societies Employment Bureau, 546; Resolution by, Relative to Votes of Trustees of United Engineering Society, 547; Resolution by, Authorizing Appointment of Committee on Honorary Membership, 547; Approval by, Of Appointment of Daniel Bontecou on Committee on Development, 883; Acceptance by, Of Resignation of C. M. Holland as Member of Committee on Development, 883; Approval by, Of Exemption of Dues of Members in Service, 883; Report to, and Action by, On Appointment of Representatives of Society on Joint Committee on Culvert Pipe Specifications, 883, 934; Appointment by, Of Special Committee on Highway Engineering, 884, 993; Action by, Relative to Change in Name of New York Meetings Committee, 884; Appointment by, Of Programme Committee for Second Meeting of Each Month, 884, 938; Report to, and Action by, On Revised Constitution of American Engineering Standards Committee, 884; Report to, and Action by, On Resolution of Founder Societies Finance Committee Relative to Appropriation for Work of American Engineering Standards Committee, 884; Report to, and Action by, On Resignation of Onward Bates as Chairman and Member of Committee on Development, 884; Presentation to, Of Report of Committee on Development, with Letters, 884; Report to, Relative to Appointment of, and Work of, Sub-Committee on Budget by Committee on Development, 884; Resolution by, Relative to Report of, Committee on Development, 885; Appointment of Committee of, To Review Report of Committee on Development, 885; Action by, Relative to Mileage for Members of Joint Conference Committee, 885; Resolution by, Relative to Appointment of Representatives of Society on Joint Committee to Formulate Specifications for Reinforced Concrete, 885; Report to, Of Nominating Committee Relative to Candidates for Officers, 885; Report to, Relative to Delay in Publication of *Proceedings*, 886; Appointment by, Of Members of Permanent Franco-American Engineering Committee, 886; Report to, and Action by, On Recommendations of Founder Societies Finance Committee on Appropriation for

Work of Engineering Societies Employment Bureau and Engineering Council, 886; Action by, On Report of Robert A. Cummings on Dedication Ceremonies of Buildings at Pittsburgh Experiment Station, 886, 935; Approval by, Of Constitution of Connecticut Association, 887; Report to, and Action by, On Resolution of San Diego Association on Creation of Department of Public Works, 887; Authorization by, Of Appointment of Committee of Arrangements for Annual Meeting, 887; Appointment by, Of F. S. Curtis on John Fritz Medal Board of Award, 887; Appointment by, Of Harry Hawgood as Chairman of Local Committee of Arrangements for 1920 Annual Convention, 887; Action by, On Resolution of C. E. Grunsky on Publication of Professional Directory of Engineers, 887.

Board on Wages and Working Conditions of U. S. Railroad Administration.—Hearing by, Relative to Classification and Compensation of Railway Engineers, 494.

Bock, Carl August.—Transferred to Grade of Member, 871.

Bohannon, John Neil.—Elected a Junior, 875.

Bonney, Guy.—Elected an Associate Member, 410.

Bontecou, D.—Presides at Meeting, 535; Discussion by, 878; On Committee on Development, 883; On Sub-Committee on Budget of Committee on Development, 885.

Boorman, K. M.—Discussion by, 413.

Boorman, T. Hugh.—Discussion by, 460, 539.

Borstelmann, Louis John.—Elected a Junior, 881.

Boucher, W. J.—Discussion by, 413.

Bowen, Edward Withers.—Transferred to Grade of Associate Member, 538.

Bower, Andrew Thomas.—Elected a Junior, 875.

Bowman, Bion Angelo.—Elected a Member, 410.

Bowman, Hubert Dickson.—Elected an Associate Member, 879.

Bowman, James Schenck.—Elected an Associate Member, 874.

Boyajohn, Haig Milton.—Transferred to Grade of Member, 411.

Boyle, Thomas Joseph.—Elected an Associate Member, 118.

Brainard, Owen.—Death announced, 462.

Breed, H. Eltinge.—Address by, 459; Discussion by, 460; On Committee on Highway Engineering, 884.

Brice, Harvey Courtright.—Elected a Member, 410.

Bright, Charles Edwin.—Death announced, 462.

Brockman, George Fred.—Elected an Associate Member, 869.

Brockway, Warner Cotton.—Elected a Junior, 461.

Brooklyn Engineers Club.—Resolutions of, Relative to Dismissal of Engineering Employees of Public Service Commission, 128, 141.

Brooks, Frederick.—Death announced, 122.

Brooks, R. E.—Shows Moving Picture Films of New Devices for Highway Construction, 460.

Brooks, Raymond Wentworth.—Transferred to Grade of Associate Member, 412.

Brown, Earl Daniel.—Transferred to Grade of Associate Member, 872.

Brown, Eugene Baker.—Elected an Associate Member, 460.

Brown, Jesse Fred.—Elected an Associate Member, 460.

Brown, Paul G.—On Advisory Engineering Committee for New York State, 311; Discussion by, 409, 878; On Programme Committee for Second Meeting of Each Month, 884, 938; Letter from, Relative to Report of Committee on Development, 884, 924.

Brown, Ralph Henry.—Death announced, 412.

Brown, Rodman Merritt.—Transferred to Grade of Member, 871.

Browne, Wolstan Elliot.—Elected an Associate Member, 460.

BRUCE

Bruce, Ernest Arden.—Elected an Associate Member, 460.
Brush, William W.—Discussion by, 877, 879.
Bryant, B. H.—Discussion by, 878.
Bucher, Henry.—Elected an Associate Member, 869.
Buck, Edward Clarke.—Elected a Member, 873.
Buck, George Herman.—Elected a Junior, 875.
Buck, R. S.—Resolutions by, Relative to the Prosecution of Reconstruction Work, 121, 145.
Buckbee, Neil Stanley.—Elected a Member, 541.
Budget System, National.—Statement Relative to Action of Congress on, 800; Hearing of Engineering Council's Representative before National Budget Committee on, 929.
Buell, Walter Augustus.—Transferred to Grade of Associate Member, 120.
Building Industry, National Board for Jurisdictional Awards in.—Organization of, 817.
Bumsted, Eugene Bradford.—Transferred to Grade of Member, 543.
Burdette, Charles Roland.—Elected an Associate Member, 869.
Burke, Edmund Potts.—Elected an Associate Member, 410.
Burke, Michael Joseph.—Elected a Junior, 543.
Burnell, Eugene Dickinson.—Transferred to Grade of Member, 871.
Burnquist, J. A. A.—Address by, 540, 548.
Burr, Edward.—Discussion by, 873.
Burr, Frank Marvin.—Elected an Associate Member, 541.
Burt, Henry Jackson.—Appointed Representative of Society on American Engineering Standards Committee, 127, 464; Report to Board of Direction on Appropriation for Work of American Engineering Standards Committee, 884.
Bushnell, Horace Leland.—Elected a Member, 879.

BUTLER

Butler, Alban Francis.—Elected a Junior, 870.
Butler, Alfred Dickey.—Transferred to Grade of Member, 882.
Butler, Drury.—Elected a Member, 868.
Butterfield, Dyer.—Elected an Associate Member, 410.
Butts, Wendell Morris.—Elected an Associate Member, 874.
Buzby, Arthur Dudley.—Elected an Associate Member, 879.
Byrne, E. A.—Discussion by, 409,490.

Cahill, James Edward.—Transferred to Grade of Member, 871.
Cairns, George Holloway.—Elected a Member, 118.
Caldwell, Fred Edward.—Transferred to Grade of Member, 538.
Calland, Robert Stewart.—Elected an Associate Member, 410.
Camlin, William John.—Elected a Junior, 537.
Cappelen, F. W.—On Local Committee of Arrangements for Annual Convention, 429, 495.
Carey, William Nelson.—Transferred to Grade of Member, 876.
Carman, Charles Bloomfield.—Elected an Associate Member, 410.
Carnegie, Andrew.—Death announced, 706; Resolutions on Death of, 813.
Carpenter, Ford Ashman.—Elected an Associate, 543.
Carpenter, Rolla Clinton.—Death announced, 123.
Carrel, William Joseph.—Elected an Associate Member, 874.
Carruthers, Robert Bruce.—Elected an Associate Member, 879.
Carson, Harry Young.—Elected an Associate Member, 874.
Carter, Edward Fairbank.—Elected a Member, 410.
Case, Ray Norman.—Elected an Associate Member, 874.
Casey, Hugh John.—Elected a Junior, 881.
Cassel, Charles Cadwallader.—Elected an Associate Member, 874.
Castle, S. N.—Discussion by, 539, 879.

CHACE

CHACE, THOMAS FRANKLIN.—Elected an Associate Member, 869.
Chamber of Commerce of the United States.—Election of Engineering Council as Member of, 930.
CHAMBERS, CHARLES.—Elected an Associate Member, 542.
CHANDLER, EMERSON LAWRENCE.—Transferred to Grade of Associate Member, 412.
CHANDLER, JERMAIN.—Elected an Associate Member, 410.
CHANNING, J. PARKE.—Letter to President Wilson from, As Chairman of Engineering Council, Urging Appointment of Engineer on Interstate Commerce Commission, 801; Letter from, As Chairman of Engineering Council, Relative to WORK of American Association of Engineers, 933.
CHAPIN, FRANKLIN HENRY.—Elected an Associate Member, 118.
Chapin, R. C., Fellowship in Highway Engineering.—Terms of, 956.
CHAPMAN, RONALD FARQUHAR.—Elected an Associate Member, 410.
CHAPMAN, VERNI JAY.—Elected an Associate Member, 460.
CHARTON, PIERRE.—Elected a Member, 536.
Chemistry and Physics, Research Fellowship in.—Announcement of Establishment of, 428.
CHENERY, C. T.—Discussion by, 867.
CHEVALIER, W. T.—Discussion by, 879.
CHILD, JOHN TOWNSHEND.—Transferred to Grade of Associate Member, 872.
CHISOLM, EDWARD NORTH, JR.—Elected a Member, 873.
CHITTENDEN, ALBERT FREDERICK.—Transferred to Grade of Member, 461.
CHRISTHILF, AUGUST EWALDT.—Elected a Member, 868.
CHRISTIAN, VALENTINE.—Elected a Junior, 881.
CHURCH, CHARLES TITUS.—Death announced, 872.
City Limits.—Fixed by Automobiles and Good Roads, 482.
"Civic Responsibilities of the Engineer", Extract from Article by Mortimer E. Cooley, on, 469.

CLAPPER

CLAPPER, LELAND.—Transferred to Grade of Member, 882.
CLARK, FRANK JOSHUA.—Elected an Associate Member, 542.
CLARK, GEORGE H.—Elected a Director, 122, 149; On Finance Committee, 129.
CLARK, HALE AUSTIN.—Elected an Associate Member, 460.
CLARKE, ERNEST WILDER.—Paper by, 795; Discussion by, 795.
Classification and Compensation of Engineers, Committee of Engineering Council on.—Letter from Chairman of, 797.
CLAUSSEN, OSCAR.—On Local Committee of Arrangements for Annual Convention, 429, 495.
CLAUSSEN, THOMAS HIBBEN.—Elected a Junior, 881.
CLAY, JAMES SINGLETON.—Elected an Associate Member, 536.
CLEARY, ALFRED JOHN.—Transferred to Grade of Member, 882.
CLEARY, JOHN BELFORD.—Elected a Junior, 870.
Cleveland Association.—Abstract of Minutes of Meetings of, 206, 318, 712, 978; Resolutions of, Relative to Work of the Committee on Development, 318, 467; Action of Board of Direction on Resolutions of, Relative to Work of Committee on Development, 467.
CLOW, PERCIVAL.—Elected a Member, 460.
COBB, WILLIAM RICHARD.—Transferred to Grade of Associate Member, 462.
COCHRAN, ROBERT LEROY.—Elected an Associate Member, 869.
COCKROFT, EDGAR.—Elected an Associate Member, 410.
COE, DENZIL WORRELL.—Elected a Member, 879.
COEYTAUX, CHARLES HENRI.—Elected an Associate Member, 542.
COFFEY, WALTER MARION.—Elected an Associate Member, 879.
COFFMAN, CLYDE DANIEL.—Elected an Associate Member, 410.
COHILL, ANDREW ARNOLD.—Elected a Member, 118.
COLBY, ALBERT LADD.—Appointed to Represent Society at Meeting of

American Institute of Mining Engineers, 127.

Cole, Ernest Delevan.—Transferred to Grade of Member, 876.

Coleman, John F.—On Finance Committee, 129; On Committee on Honorary Membership, 682.

Coles, Stephen L.—Appointed Assistant Secretary, 313, 464.

Collations.—Approval by Board of Direction of Request of New York Meetings Committee Relative to, At Society Meetings, 129.

Collective Bargaining, Professions Not Organized for.—Comment on, 802.

Collingwood Prize.—Award of, 116, 133.

Collins, Arthur Burr.—Elected an Associate Member, 879.

Collins, Earl Harry.—Transferred to Grade of Associate Member, 872.

Collins, John Lambert.—Elected an Associate Member, 410.

Collisson, William Henry, Jr.—Elected an Associate Member, 118.

Colorado Association.—Abstract of Minutes of Meetings of, 205, 317, 499, 711, 977.

Columbia, Curtis Fields.—Transferred to Grade of Associate Member, 882.

Combs, Claude Artist.—Elected an Associate Member, 879.

Commercial and Industrial Bureau of the Polish National Department.—Statement Relative to Work of, 427.

Committee, Advisory Engineering, of State of New York.—Appointment of, 311.

Committee, American Engineering Standards. *See* American Engineering Standards Committee.

Committee, Executive, of Board of Direction. *See* Executive Committee of Board of Direction.

Committee, Founder Societies Finance. *See* Founder Societies Finance Committee.

Committee, License, of Engineering Council. — Statements by, On State Laws for Licensing Engineers, 815.

Committee, National Service. *See* National Service Committee.

Committee, New York Meetings.—Approval by Board of Direction of Request of, Relative to Collations at Society Meetings, 129; Name Changed, 884.

Committee of Arrangements for Annual Convention.—Appointment of, 129, 429, 495; Appointment by Board of Direction of Chairman of Local, 887.

Committee of Arrangements for Annual Meeting.—Appointment of, 887, 972.

Committee of Board of Direction to Consider Question of Assistant Secretary.—Resolution Relative to Appointment of, 130; Appointment of, 130.

Committee of Board of Direction to Consider the Matter of Representatives of Society on American Engineering Standards Committee.—Report of, 127.

Committee of Board of Direction to Review Report of Committee on Development. — Appointment of, 885.

Committee of Engineering Council on Classification and Compensation of Engineers.—Letter from Chairman of, 797.

Committee on Alfred Noble Memorial. —Progress Report of, 117, 140.

Committee on Classification of Personnel in the United States Army.—Statement Relative to Exhibit of Work of, 310.

Committee on Development of the American Society of Civil Engineers.—Progress Report of, 117, 141, 540, 545, 551, 589, 889; Action of Board of Direction Relative to Resolutions of Duluth Association and Other Local Associations on, 125, 200; Approval by Board of Direction of Action by Executive Committee Relative to Progress Report of, For Presentation to Annual Convention, 464; Appropriation by Board of Direction for Work of, 466; Resolutions of Cleveland Association Relative to Work of, 318, 467; Action of Board of Direction Relative to Resolutions of Cleveland Association on Work of, 467; Resolution of Board of Direction

COMMITTEE

Expressing Confidence in Work of, 467; Message from Board of Direction Expressing Sympathy, etc., with Work of, 467; Action by Southern California Association Relative to Work of, 325, 467; Report to, and Action by, Board of Direction Relative to Action by Southern California Association on Work of, 467; Discussion on Report of, 541, 552, 878, 920; Report of Committee on Special Committees on Work of, 545, 685; Resolution of Board of Direction Relative to Presentation and Distribution of Progress Report of, 545; Resolution of Board of Direction Authorizing Additional Meeting of, 545; Statement to, and Action by, Board of Direction Relative to Request to Add Explanatory Matter to Progress Report of, 545; Resolution of Board of Direction Authorizing Addition of Explanatory Matter to Progress Report of, 545; Resolution of Board of Direction Requesting Onward Bates to Continue as Chairman of, 545; Announcement of September, 1919, Meeting of 799; Appointment of Daniel Bontecou as Member of, Approved, 883; Resignation of C. M. Holland as Member of, Accepted, 883; Resignation of Onward Bates as Chairman and Member of, Accepted, 884; Report of, with Letters on, Presented to Board of Direction, 884; Appointment of Sub-Committee on Budget by, 884; Resolutions of Board of Direction on Report of, 885; Discharge of, 885; Appointment of Committee of Board of Direction to Review Report of, 885; Letters Relative to Report of, 920.

Committee on Engineering Education.—Final Report of, 116, 134; Discharge of, 117.

Committee on Establishment of Student Branches of the Society.—Majority and Minority Reports of, 124.

COMMITTEE

Committee on Finance.—Statement by, To Board of Direction, 123, 129, 544, 681; Appointment of, 129.

Committee on Highway Engineering.—Report of Committee on Special Committees on Appointment of, 545, 687; Appointment of, 884, 993.

Committee on Honorary Membership.—Resolution of Board of Direction Authorizing Appointment of, 547; Appointment of, 682.

Committee on Iron and Steel Structures of American Railway Engineering Association.—Appointment of Committee to Confer with the, 468.

Committee on Library.—Appointment of, 129; Report of, To Board of Direction Relative to Engineering Societies Library, 544, 683.

Committee on Licensing Engineers of San Francisco Association.—Report of, 6.

Committee on Nominations.—Report of Tellers Appointed to Canvass Final Suggestions for, 116, 128, 133, 134; Presents List of Nominees, 885, 972.

Committee on Organization of Franco-American Engineering Committee.—Report of, To Board of Direction, 546.

Committee on Publications.—Appointment of, 129; Request of, Relative to Contributions to *Proceedings*, 431, 495; Report of, To Board of Direction, Relative to Changes in Style in Year Book and *Proceedings*, 463; Request of, Relative to Memoirs of Deceased Members, 491; Instructions to, By Board of Direction, Relative to Changes in Year Book and *Proceedings*, 545.

Committee on Reconstruction.—Report of Committee on Special Committees Recommending Discharge of, 545, 685.

Committee on Regulation of Water Rights.—Progress Report of, 117, 140; Report of Committee on Special Committees on Work of, 545, 686.

COMMITTEE

Committee on Special Committees.—Progress Report of, 125, 545, 685; Appointment of, 129.

Committee on Technical Symbols.—Action of Board of Direction Relative to Appointment of Representative of Society on, and Appropriation for, 127.

Committee, Patent, of National Research Council.—Report of, 197.

Committee, Permanent Franco-American Engineering.—Appointment of Members of, 886, 938.

Committee, Programme, for Second Meeting of Each Month.—Appointment of, 884, 938.

Committee to Codify Present Practice on Bearing Value of Soils for Foundations, etc.—Progress Report of, 117, 138; Minutes of Meeting of, 218, 990; Report of Committee on Special Committees on Work of, 545, 685.

Committee to Confer with Committee on Iron and Steel Structures of American Railway Engineering Association, 468.

Committee to Prepare Engineering Problems and Judge Competitions for Technological Schools.—Action by Board of Direction Relative to, 124; Report of Committee on Special Committees on, 545, 687.

Committee to Recommend the Award of Prizes.—Report of, 116, 127, 132; Appointment Authorized, 468; Appointment of, 546, 684.

Committee to Report on Stresses in Railroad Track.—Progress Report of, 117, 139; Report of Committee on Special Committees on Work of, 545, 686; Appointment of Additional Members of, 887; Minutes of Meeting of, 991.

Committee to Secure Discussion of Dr. Mann's Report on Engineering Education.—Resolution Relative to Appointment of, 116, 136.

Committees of the Society. *See also* Joint Committees.

Committees, Special.—Progress Report of Committee on, 125, 545, 685; Appointment of Committee on, 129; Minutes of Meetings of, 218, 990.

COMMITTEES

Committees, State Reconstruction.—Statement Relative to Appointment of, and Work of, 477.

Comstock, Harold Dearborn.—Transferred to Grade of Member, 411.

Conant, Luther Chittenden.—Elected an Associate Member, 874.

Concrete, Reinforced. — Structural Laboratory Investigations in, 954.

Concrete, Reinforced, Joint Committee to Formulate Specifications for.—Appointment of Representatives of Society on, Authorized, 885; Appointment of, 934.

Conference on Business Training for Engineers, etc.—Report of, 421, 491, 698; Appointment of Representative of Society to, 546.

Congrès Général du Génie Civil. *See* Joint Engineering Congress, Paris, 1918.

Connecticut Association. — Constitution approved, 887.

Conner, Perley Eugene.—Elected an Associate Member, 460.

Conrad, Harry Lester.—Elected an Associate Member, 874.

Constant, Clyde Stanley.—Elected a Junior, 875.

Construction Activity. — Statement Relative to Co-Operation of Government in Restoration of, 195, 473.

Consulting Engineers, American Institute of.—Letter to President Wilson from Council of, Criticizing the Plumb Plan for Railroads, 803.

"Contracts—A Comparison of 'Cost Plus' with Other Forms", presented and discussed, 795.

Convill, James Oscar.—Elected an Associate Member, 410.

Conway, J. S.—On Nominating Committee, 116, 128, 133, 134; Discussion by, 877.

Cooke, Norman Homer.—Elected an Associate Member, 879.

Cooley, Mortimer E.—Extracts from Articles by, On Technical Education and Civic Responsibilities of the Engineer, 469.

COOMBES, JAMES LESLIE.—Elected an Associate Member, 869.
COOMBS, DONALD GLADSTONE.—Transferred to Grade of Associate Member, 876.
COOMBS, R. D.—Discussion by, 873.
COOPER, THEODORE.—Death announced, 796.
COPELAND, FREDERIC LUCIUS.—Transferred to Grade of Member, 876.
CORBIN, HORACE KELLOGG.—Transferred to Grade of Associate Member, 412.
CORKRAN, WILBUR SHERMAN.—Transferred to Grade of Member, 461.
CORMAN, WILLIAM.—Elected a Junior, 875.
CORNELL, JOHN WESLEY.—Transferred to Grade of Member, 543.
Cornell University.—Statement Relative to Contents of Library of, 426.
CORWIN, DANIEL CHAUNCEY.—Elected an Associate Member, 410.
COSBY, JOHN HAMILTON.—Elected an Associate Member, 536.
COTTON, HARRY EDMOND.—Elected an Associate Member, 869.
COTTRELL, CLARKE COPELAND.—Transferred to Grade of Member, 871.
COULSON, HORACE WILKINSON.—Elected an Associate Member, 869.
COUNTY, A. J.—Discussion by, 122.
COURTENAY, WILLIAM ALOYSIUS, JR.—Elected an Associate Member, 874.
COVELL, VERNON ROYCE.—Transferred to Grade of Member, 871.
COWLES, MARTIN WARREN.—Elected a Junior, 461.
COX, D. H.—Invitation from, To Visit Yard of Fougner Shipbuilding Company, 121, 144.
COX, DAVID JESSE.—Elected an Associate Member, 874.
COX, WILLIAM JUNKIN.—Elected a Junior, 870.
CRAIG, ROBERT HALL.—Elected an Associate Member, 874.
CRAIG, WALTER DUNLAP.—Elected an Associate Member, 460.
CRAIGMILE, CHARLES JAMES.—Elected an Associate Member, 874.
CRAM, CLYDE MAXWELL.—Elected a Member, 868.
CRAMER, WILLIAM NATHANIEL.—Elected an Associate Member, 410.
CRANE, A. S.—Appointed Teller to Canvass Ballot for Officers, 115, 131, 150; On Committee to Recommend the Award of Prizes, 546, 684.
CRANE, JACOB LESLIE, JR.—Transferred to Grade of Associate Member, 462.
CRAVEN, WILLIAM DARCY, JR.—Elected an Associate, 881.
CRAVER, HARRISON W.—Letter from, As Secretary of Library Board, Relative to Contributions of Books for Library of University of Louvain, 937.
CRISTAL, PHILIP NAHM.—Elected a Junior, 875.
CRITCHER, ALAN HAWES.—Elected an Associate, 875.
CRITZAS, EVANGELOS JOHN.—Elected a Junior, 870.
CROCKER, HERBERT S.—Elected a Vice-President, 122, 149; On Finance Committee, 129; On Committee of Board of Direction to Consider Question of Assistant Secretary, 130; Presides at Meeting, 172; On Committee on Honorary Membership, 682; On Committee of Board of Direction to Review Report of Committee on Development, 885.
Croes Medal.—Award of, 116, 132.
CRONHOLM, FREDERICK N.—Transferred to Grade of Member, 871.
CROSS, WILLIAM CLARENCE.—Elected an Associate Member, 879.
Cuba, Association of Members of American National Engineering Societies in.—Organization Announced, 490.
Cuba, National Census Board of.—Appointment of Engineer on, 953.
CUDWORTH, FRANK EZEKIEL.—Elected a Member, 873.
CUFF, JAMES EDWARD.—Elected an Associate Member, 536.
Culvert Pipe Specifications, Joint Committee on.—Appointment of Representatives of Society on, 883, 934.
CUMMINGS, ROBERT A.—Presents Progress Report of Special Com-

mittee to Codify Present Practice on Bearing Value of Soils for Foundations, etc., 117, 138; Appointed to Represent Society on Board of Directors of American Welding Society, 492, 546; Discussion by, 541, 554; Report of, To Board of Direction on Ceremonies at Dedication of Buildings at Pittsburgh Experiment Station, 886, 935; Nominated as Vice-President, 972.

Current Engineering Literature, 102, 279, 394, 445, 517, 752, 836, 1021.

CURTIS, BENJAMIN JOHN.—Transferred to Grade of Associate Member, 544.

CURTIS, FAYETTE S.—Elected President, 122, 149; Presides at Meetings, 122, 289, 412, 540, 550, 872; Address by, 540, 550; On Committee on Honorary Membership, 682; Discussion by, 872; On John Fritz Medal Board of Award, 887.

CURTISS, GREY WILLIS.—Elected an Associate Member, 542.

DAKIN, ROBERT EDWARD.—Death announced, 120, 144.

DALEN, JOHN ALBERT.—Elected an Associate Member, 542.

DANIELLS, PAUL ASHMORE.—Elected an Associate Member, 536.

DARLING, J. H.—On Committee of Arrangements for Annual Convention, 129, 429, 495; Letter from, Relative to Report of Committee on Development, 920.

DARLINGTON, EDWARD BRINTON.—Elected a Member, 873.

DAVIES, J. V.—Re-elected a Representative in United Engineering Society, 127; Discussion by, 409.

DAVIS, ARTHUR P.—On Library Committee, 129; Discussion by, 795; Nominated as President, 972.

DAVIS, CHESTER BIRGE.—Death announced, 872.

DAVIS, FRANK HILL.—Transferred to Grade of Member, 876.

DAVIS, H. C., JR.—Discussion by, 536.

DAVIS, RAYMOND EARL.—Elected an Associate Member, 536.

DAWLEY, WALTER MANDEVILLE.—Elected a Member, 460; On Committee to Report on Stresses in Railroad Track, 887.

DAY, WILLARD FARNSWORTH.—Elected a Junior, 870.

DEAN, NORMAN DOUGLAS.—Elected an Associate Member, 460.

DEANS, JOHN STERLING.—Death announced, 2.

DEANS, JOHN STERLING, JR.—Elected an Associate Member, 869.

DE JONGH, ARTHUR FRANCIS.—Transferred to Grade of Associate Member, 872.

DE LA BARRE, WILLIAM.—On Local Committee of Arrangements for Annual Convention, 429, 495.

DELANO, EDWARD WARREN.—Elected a Member, 460.

Delegation of American Engineers to Joint Engineering Congress, Paris, 1918.—Report to Board of Direction Relative to Appointment of, By Executive Committee, 125; Action of Board of Direction Relative to Resolutions of Duluth Association on Appointment of, 125, 198; Addresses by, 172; Report of, 604.

DE LEUW, CHARLES EDMUND.—Transferred to Grade of Associate Member, 544.

DEMAREST, IRVING.—Elected an Associate Member, 879.

DENHAM, DONALD POWER.—Death announced, 2.

DENNETT, ROBERT CLARK.—Elected an Associate Member, 542.

DENNIS, WALTER.—Elected a Member, 541.

"Designing an Earth Dam Having a Gravel Foundation, with the Results Obtained in Tests on a Model", Awarded the Collingwood Prize for Juniors, 116, 133.

Detroit Edison Fellowship in Highway Engineering.—Terms of, 956.

"Development of New Jersey's Highway System and Its Relation to Hudson River Vehicular Tunnels and Ferries", Address on, 459.

Development of Professional Engineering.—Action of Board of Direction on Resolutions of Kansas City Engineering Society, Ohio Engineering Society, and

DEVELOPMENT

Rochester Engineering Society Relative to, 466.

Development of the American Society of Civil Engineers, Committee on. —Progress Report of, 117, 141, 540, 545, 551, 589, 889; Action of Board of Direction Relative to Resolutions of Duluth Association and Other Local Associations on, 125, 200; Approval by Board of Direction of Action of Executive Committee Relative to Progress Report of, For Presentation to Annual Convention, 464; Appropriation by Board of Direction for Work of, 466; Resolutions of Cleveland Association Relative to Work of, 318, 467; Action of Board of Direction on Resolutions of Cleveland Association Relative to Work of, 467; Resolution of Board of Direction Expressing Confidence in Work of, 467; Message from Board of Direction Expressing Sympathy, etc. with Work of, 467; Action by Southern California Association Relative to Work of, 325, 467; Report to, and Action by, Board of Direction Relative to Action of Southern California Association on Work of, 467; Discussion on Report of, 541, 552, 878, 920; Report of Committee on Special Committees on Work of, 545, 685; Resolution of Board of Direction Relative to Presentation and Distribution of Progress Report of, 545; Resolution of Board of Direction Authorizing Additional Meeting of, 545; Statement to, and Action by, Board of Direction Relative to Request to Add Explanatory Matter to Progress Report of, 545; Resolution of Board of Direction Authorizing Addition of Explanatory Matter to Progress Report of, 545; Resolution of Board of Direction Requesting Onward Bates to Continue as Chairman of, 545; Announcement of September, 1919, Meeting of, 799; Appointment of Daniel Bontecou as Member of, Approved, 883; Resignation of C. M. Holland as Member of, Accepted, 883; Resignation of Onward Bates as Chairman and Member of, Accepted, 884; Report of, with Letters on, Presented to Board of Direction, 884; Appointment of Sub-Committee on Budget by, 884; Resolutions of Board of Direction on Report of, 885; Discharge of, 885; Appointment of Committee of Board of Direction to Review Report of, 885; Letters Relative to Report of, 920.

DEWEY

Dewey, Clarence Lennon.—Elected an Associate, 881.

Dias, Moacyr Rodrigues.—Elected a Junior, 411.

Dickerson, O. H.—Discussion by, 541, 571.

Dinsmore, Oliver Raymond.—Elected an Associate Member, 118.

Dirats, Janik Kevork.—Transferred to Grade of Associate Member, 538.

Directory, Professional, of Engineers. —Resolution of C. E. Grunsky Relative to Publication of, 887.

Disbrow, Clarkson Alcott.—Elected a Member, 873.

District of Columbia Association.— Abstract of Minutes of Meetings of, 207, 979.

Dittoe, William Henry.—Transferred to Grade of Member, 871.

Doane, Hervey Kinch.—Elected an Associate Member, 410.

Doane, Ralph Avard.—Elected an Associate Member, 869.

Dobson, Adna.—Death announced, 538.

Dobson, Gilbert Colfax.—Transferred to Grade of Member, 411.

Doland, James Joseph.—Elected an Associate Member, 874.

Dotens, Leonard S.—Address by, 1; Discussion by, 1.

Dougan, William Thomas.—Death announced, 290.

Dougher, William Edward.—Elected an Associate Member, 874.

Dougherty, Nathan Washington.— Elected an Associate Member, 118.

Dow, Edwin Arthur.—Transferred to Grade of Associate Member, 876.

Dowd, Munson Julius.—Elected a Junior, 119.

Downs, William Smith.—Elected a Member, 873.

Drake, Ralph Edmund.—Transferred to Grade of Associate Member, 412.

Dresser, Elbert Hermon.—Elected a Member, 868.

Du Bois, Francis Wheelock.—Elected an Associate Member, 874.

Dubois, Gustavo Adolfo.—Death announced, 123.

Duby, Clarence Joseph.—Elected an Associate Member, 879.

Duckwall, Anderson Edward.—Elected an Associate Member, 410.

Duerr, Raymond.—Elected an Associate Member, 542.

Dues, Remittance of.—Action of Executive Committee Relative to, Approved, 883.

Dugan, Frank Clarke.—Elected an Associate Member, 410.

Duluth Association.—Action by Board of Direction Relative to Resolutions of, On Appointment of Delegates to Joint Engineering Congress, Paris, 125, 198; Action by Board of Direction Relative to Resolutions of, On Committee on Development, 125, 200; Abstract of Minutes of Meetings of, 207, 319, 432, 500, 713, 826, 980; Action by, Relative to Adoption by Engineering Council of News Bulletin, 209, 467; Report to, and Action by, Board of Direction Relative to Action by, Recommending Adoption by Engineering Council of News Bulletin, 467.

Dunham, H. F.—Discussion by, 1, 868, 872.

Dunmire, Elijah Herbert.—Transferred to Grade of Member, 871.

Dunn, Everett Wesley.—Elected an Associate Member, 118.

Dunn, Gano.—Presides at Engineers' Symposium, 418.

Dust Explosions and Fires.—Legislation to Investigate and Prevent, 946.

Eberhard, Arthur Charles.—Elected a Junior, 870.

Eberly, Clarence Frederick.—Death announced, 120, 144.

Eckels, Samuel.—Elected an Associate Member, 874.

Edes, Edward Louis.—Elected an Associate Member, 869.

Edinburgh, Scotland, Electric Lighting, Committee of.—Statement Relative to Bids for Machinery for, 964.

Edison, Thomas A.—Abstract of Message to Annual Convention of Edison Dealers, on "Square Deal", 694.

Edison Medal.—Award of, 690.

Education. *See* Engineering Education.

Edy, John North.—Transferred to Grade of Member, 871.

Ehrenborg, George Georgsson.—Elected an Associate Member, 869.

Elcock, Charles.—Elected an Associate Member, 542.

11th Engineers.—Parade of, In New York City, 480; Col. Parsons' Farewell Address to, 689.

Ellis, Richard.—Elected an Associate Member, 542.

Elston, Allan Vaughn.—Elected an Associate Member, 460.

Elton, Herbert Charles.—Elected an Associate Member, 874.

Elwell, Charles C.—Elected a Director, 122, 149; On Publication Committee, 129.

Emerson, Charles John.—Elected an Associate Member, 536.

Emerson, George Dana.—Transferred to Grade of Member, 461.

Employment Bureau, Engineering Societies.—Organization of, 14, 203, 313, 430, 496; Letters to Governors of States Relative to Work of, 302; Request to, To Assist Joint Employment Service of Federal, State, and Civic Bodies, 492; Authorization by Board of Direction of Appropriation for, 546; Statement of Work of, 692, 934; Report to and Action by, Board of Direction on Resolutions of Founder Societies

ENGINEERING

Finance Committee on Appropriation for Work of, 886.
"Engineering Activities of the Twin Cities", Address on, 540, 550, 580.
Engineering, Advisory, Committee of State of New York.—Appointment of, 311.
Engineering Congress, Java, 1920.—Change of Time Announced, 422; Appointment of John R. Freeman to Convey Salutations of Society to, 492.
Engineering Congress. *See also* Joint Engineering Congress.
"Engineering Construction in Russia, and General Conditions in That Country from the Viewpoint of an Engineer", presented and discussed, 290.
Engineering Council.—Appointment of Representatives of Society on, 125, 464; Action of Board of Direction Relative to Request of, For Appropriation for Work of National Service Committee, 126; Selects Personnel of Advisory Engineering Committee for New York State, 311; Urges Rapid Completion of Topographic Map of United States, 422; Appointment of A. S. Baldwin to Represent Society at Conference Called by National Service Committee of, to Consider Establishment of National Department of Public Works, 464, 492; Prospectus of Work of National Service Committee of, Presented to Board of Direction, 464; Resolution of Board of Direction Approving Work of National Service Committee of, As Presented in Prospectus, 464; Resolution of, Relative to Additional Contribution Needed for Work of National Service Committee of, 466; Resolutions of Board of Direction Relative to Additional Contribution for Work of National Service Committee of, 466; Report to, and Action by, Board of Direction Relative to Action of Duluth Association Recommending Adoption by, of News Bulletin, 467; Report of Conference Called by National Service Committee of,

ENGINEERING

To Consider Establishment of National Department of Public Works, 474; Announces Establishment of National Legislative and Departmental Information Service for Engineers, 482, 973; Activities of, 698, 929; Letter from Chairman of Committee on Classification and Compensation of Engineers of, 797; Information from National Service Committee of, 800, 818, 929; Letter to President Wilson from Chairman of, Urging Appointment of Engineer on Interstate Commerce Commission, 801; Statement of License Committee of, On State Laws for Licensing Engineers, 815; Report to, and Action by, Board of Direction on Resolutions of Founder Societies Finance Committee on Appropriations for Work of, 886; Hearing of, Before National Budget Committee, 929; Election of, To Membership in U S. Chamber of Commerce, 930; Action by, Relative to Promotion of a National Department of Public Works, 932; Letter from Chairman of, Relative to Work of American Association of Engineers, 933.
Engineering Delegates, American, to Joint Engineering Congress, Paris, 1918.—Report to Board of Direction Relative to Appointment of, By Executive Committee, 125; Action of Board of Direction Relative to Resolutions of Duluth Association on Appointment of, 125, 198; Addresses by, 172; Report of, 604.
Engineering Division of National Research Council.—Minutes of Meeting of, 3; Appointment Authorized, and Appointment of, Representatives of Society on, 466, 492, 546; Aims of, 476.
Engineering Education, Report of Dr. Mann on.—Presented and Accepted as Final Report of Special Committee on Engineering Education, 116, 134; Resolution Relative to Appointment of Committee to Secure Discussion of, 116, 136.

ENGINEERING

Engineering Education, Special Committee on.—Final Report of, 116, 134; Discharge of, 117.

Engineering Employees of New York State Public Service Commission.—Resolutions of Board of Direction Relative to Dismissal of, 117, 128, 141, 142; Resolutions of Brooklyn Engineers Club Relative to Dismissal of, 128, 141.

Engineering, Highway, Committee on.—Report of Committee on Special Committees on Appointment of, 545, 687; Appointment of, 884.

Engineering Institute of Canada.—Letter from, Extending Greetings to Board of Direction, 127.

Engineering Problems and Judging Competitions for Technological Schools, Committee on.—Action of Board of Direction Relative to, 124; Report of Committee on Special Committees on, 545, 687.

Engineering, School of.—Announcement Relative to Establishment of, In Pennsylvania, 817.

Engineering Societies Employment Bureau.—Organization of, 14, 203, 313, 430, 496; Letters to Governors of States Relative to Work of, 302; Request to, To Assist Joint Employment Service of Federal, State, and Civic Bodies, 492; Authorization by Board of Direction of Appropriation for, 546; Statement of Work of, 692, 934; Report to, and Action by, Board of Direction on Resolutions of Founder Societies Finance Committee on Appropriation for Work of, 886.

Engineering Societies' Library.—Accessions to, 43, 221, 330, 437, 507, 729, 833, 992; Resolutions of Library Board of United Engineering Society Relative to Recataloguing of, 123; Resolution of Board of Direction Relative to Recataloguing of, 124; Appropriation for Recataloguing of, Approved by Board of Direction, 544, 681; Report on, Of Library Committee to Board of Direction, 544, 683; Resolution of Board of Direction Relative to Ownership of Books in, 544.

ENGINEERS

Engineers', Architects', and Constructors' Conference on National Public Works.—Appointment of A. S. Baldwin to Represent Society at, 464, 492; Report of Work at, 474; Resolution by, Relative to Topographic Mapping of the United States, 488; Contributions from, 941.

Engineers, Army.—Work of, In France, 809.

Engineers, Classification and Compensation of, Committee of Engineering Council on.—Letter from Chairman of, 797.

Engineers' Club.—Resolutions by, On Death of Andrew Carnegie, 813.

Engineers Corps.—*See* United States, Engineers, Corps of,

Engineers, 11th.—Description of Parade of, In New York City, 480; Col. Parsons' Farewell Address to, 689.

Engineers, Etc., Conference on Business Training for.—Report of, 421, 491, 698; Appointment of Representative of Society to, 546.

Engineers, Licensing of.—Report of Committee of San Francisco Association on, 6; Engineers' Registration Act for Oregon, 304, 426; Discussion of, By Technical Societies, 479; Registration of Professional Engineers in Oregon, 814; State Laws for, 815; Proposed Registration of Civil Engineers in England, 962.

Engineers of India.—Movement to Organize Institution of, 813.

Engineers, Professional Directory of.—Resolution of C. E. Grunsky Relative to Publication of, 887.

Engineers, Railway, Classification and Compensation of.—Hearing by Board on Wages and Working Conditions of the U. S. Railroad Administration on, 494.

Engineers' Registration Act for Oregon, 304, 426.

Engineers' Service Bureau, San Francisco, Cal.—Announcement Relative to, 8.

Engineers' Symposium.—Abstract of Minutes of, 418.

Engineers Wanted for Consular Service.—Statement Relative to, 951.

England.—Housing Problem in, 961, 963; Registration of Civil Engineers in, 962; Centralizing Electric Supply of, 964.

English Channel Tunnel.—Statement Relative to Study of Plans for, 428.

Epple, Edward Charles.—Elected a Member, 410.

Epstein, Abraham.—Elected an Associate Member, 536.

Erickson, David Leonard.—Elected an Associate Member, 869.

Ericson, Frederick Anson.—Elected a Member, 410.

Erwin, Martin Cyral.—Elected an Associate Member, 869.

European Notes, 957.

Evans, Joseph Dean.—Address by, 535.

Everett, Martin Ryerson.—Elected a Member, 460.

Evers, Ernest.—Elected an Associate Member, 118.

Executive Committee of Board of Direction.—Adoption of Annual Report Prepared by, 124; Approval of Minutes of Meetings of, 124, 883; Report of Secretary to Board of Direction Relative to Appointment by, Of Delegates to Joint Engineering Congress in Paris, 125; Approval by Board of Direction on Action of, Relative to Progress Report of the Committee on Development for Presentation to Annual Convention, 464; Appointment by, Of A. S. Baldwin to Represent Society at Conference to Consider Establishment of National Department of Public Works, 464.

Fales, Almon L.—Discussion by, 1.

Fallis, William Stuart.—Elected a Member, 868.

Farley, P. P.—Appointed Teller to Canvass Ballot for Officers, 115, 131, 150.

Farrington, Arthur E.—Elected an Associate Member, 118.

Farris, John.—Transferred to Grade of Member, 538.

Fawley, James Linwood.—Elected a Member, 410.

Federal Electric Railways Commission.—Appointment of Members of, 692.

Ferebee, James Lumsden.—Transferred to Grade of Member, 882.

Ferguson, Louis Rapp.—Transferred to Grade of Member, 876.

Fergusson, Frank Fairchild.—Elected an Associate Member, 869.

Ferver, Arthur Lee.—Elected an Associate Member, 537.

Fichthorn, Joseph Hoover.—Elected a Member, 541.

Finance Committee.—Statement by, to Board of Direction, 123, 129, 544, 681; Appointment of, 129.

Finance Committee on Joint Activities, Founder Societies.—Resolution Recommending Appointment of, 546; Appointment of Representatives of Society on, 546, 684; Resolution by, Relative to Appropriation for Work of American Engineering Standards Committee, 884; Resolutions by, Relative to Appropriation for Work of Engineering Societies Employment Bureau and Engineering Council, 886.

Finebaum, Harry Jacob.—Elected an Associate Member, 879.

Finestone, Nathaniel.—Elected an Associate Member, 542.

Fires and Dust Explosions.—Legislation to Investigate and Prevent, 946.

Fischer, Andrew, Jr.—Elected an Associate Member, 542.

Fischer, Walter Arthur.—Elected an Associate Member, 542.

Fishach, Leyburn Grier.—Elected an Associate Member, 410.

Fisher, Alfred Philip.—Elected an Associate Member, 460.

Fisher, Chester Centennial.—Transferred to Grade of Member, 871.

Fisher, Irving.—Abstract of Statement by, Relative to New Price Revolution, 483.

FISKE

FISKE, ROBERT SEYMOUR.—Elected an Associate Member, 869.

FITCH, JOSIAH HUNTINGTON. — Elected a Member, 536.

FITZGERALD, DESMOND.—Presents Report of Dr. Mann as Final Report of Special Committee on Engineering Education, 116, 134; Resolution by, Relative to Appointment of Committee to Secure Discussion on Dr. Mann's Report on Engineering Education, 116, 136.

FITZGERALD, JAMES HENRY.—Elected an Associate Member, 869.

FITZGERALD, WILLIAM EDWARD. — Transferred to Grade of Associate Member, 462.

"Fixed Ammunition Loading, Inspecting and Firing," Address on, 535.

FLEMING, JOSEPH HAMILTON.—Transferred to Grade of Member, 461.

FLEMING, PHILIP BRACKEN.—Elected an Associate Member, 537.

FLETCHER, A. B.—On Committee on Highway Engineering, 884.

FLICK, JOHN KRAMER.—Transferred to Grade of Member, 543.

FLINN, ALFRED D.—On Library Committee, 129; Discussion by, 868.

FOGG, RALPH JUSTIN.—Elected an Associate Member, 879.

FOLK, CHARLES JAMES.—Elected an Associate Member, 542.

FOLLIN, JAMES WIGHTMAN.—Transferred to Grade of Associate Member, 538.

FONTAINE, JOHN EATON.—Elected an Associate Member, 879.

FORD, ARTHUR JENKINS.—Elected an Associate Member, 118.

FORD, WILLIAM GRIFFING.—Death announced, 796.

FORGIE, JAMES.—Appointed Teller to Canvass Ballot for Officers, 115, 131, 150; Discussion by, 409.

FORREST, THOMAS EDWARD.—Elected a Member, 873.

FOSTER, JAMES APKER, JR.—Elected a Junior, 537.

FOUHY, MICHAEL AUGUSTIN.—Elected an Associate Member, 869.

Founder Societies.—Resolutions by, On Death of Andrew Carnegie, 813.

FOUNDER

Founder Societies Finance Committee on Joint Activities.—Resolution Recommending Appointment of, 546; Appointment of Representatives of Society on, 546, 684; Resolution by, Relative to Appropriation for Work of American Engineering Standards Committee, 884; Resolutions by, Relative to Appropriation for Work of Engineering Societies Employment Bureau and Engineering Council, 886.

FOUNTAIN, THOMAS LILLY. — Transferred to Grade of Member, 876.

FOWLER, CHARLES EVAN.—Suggestion by, Relative to Appointment of Temporary Committee, to Confer with American Railway Engineering Association, on Adoption of New Column Formula, and Train Loadings, 290; Discussion by, 409.

FOX, EDWIN PHILIP.—Elected an Associate Member, 869.

FOX, ERNEST FRANZ, JR.—Elected an Associate Member, 869.

FOX, HERMAN HENRY.—Transferred to Grade of Member, 882.

FOX, ROBERT LEE.—Elected an Associate Member, 542.

FOX, ROBERT MYRON.—Elected an Associate Member, 118.

France, Reconstruction Work in.—Addresses by American Engineers Appointed to Aid in, 172; Report of Delegation of American Engineers Appointed to Aid in, 604; American Firm to Rebuild Nancy, 691; Exhibition Relative to, 960.

France, Tunnel Commission of.—Statement of Work of, 428.

Franco-American Engineering Committee, Committee on Organization of.—Report of, To Board of Direction, 546.

Franco-American Engineering Committee, Permanent. — Appointment of Members of, 886, 938.

FRANKLAND, F. H.—Discussion by, 795.

FREEMAN, JOHN R.—Appointed to Convey Salutations of Society to Engineering Congress in Java, 492.

FREEMAN, MILTON HARVEY.—Transferred to Grade of Member, 871.

FREEMAN

Freeman, Ralph.—Elected a Member, 410.

Fretz, Edmond Anthony. — Transferred to Grade of Associate Member, 538.

Frew, Archibald Smith.—Death announced, 877.

Fry, A. B.—Discussion by, 868, 879.

Fucik, Edward James.—Transferred to Grade of Member, 871.

Fuller, George W.—Address by, As Delegate to Joint Engineering Congress, Paris, 183; On Advisory Engineering Committee for New York State, 311; Discussion by, 413, 867.

Gage, Howard Elmer.—Elected an Associate Member, 879.

Gage, Ralph Hawes.—Elected a Member, 118.

Gallagher, Herbert Morgan. — Elected an Associate Member, 542.

Gamsu, Frederick Conrad.—Elected a Junior, 543.

Gardner, Leroy Ernest.—Elected an Associate Member, 460.

Garland, Eldon Addison.—Elected an Associate Member, 879.

Garrigues, Henry Haydock.—Transferred to Grade of Member, 871.

Gaston, Francisco.—Appointed Engineering Representative on Cuban National Census Board, 953.

Gates, George William.—Elected an Associate Member, 542.

Gault, John James.—Transferred to Grade of Associate Member, 538.

Gaylord, Ralph Welles. — Elected an Associate Member, 118.

Gearhart, Orval Lee.—Elected an Associate Member, 542.

Geer, Harvey Mosher.—Death announced, 413.

Geraghty, Leo Matthew.—Elected an Associate Member, 874.

Gerrish, Herbert Thurston. — Elected an Associate Member, 874.

Geupel, Carl Martin.—Elected an Associate Member, 874.

Gibbs, William Wetmore.—Death announced, 123.

Gillean, Charles Henry Howard. Death announced, 120, 144.

GILMAN

Gilman, Charles.—On Committee of Arrangements for Annual Meeting, 972.

Gilman, Charles Edward.—Transferred to Grade of Member, 543.

Glaeser, Frederick.—Elected an Associate Member, 537.

Glaettli, John, Jr.—Elected an Associate Member, 542.

Glaser, Samuel Jack.—Elected a Junior, 461.

Glessner, Maurice David.—Elected a Junior, 119.

Gochnauer, Harry Wallis.—Elected an Associate Member, 869.

Godfrey, Edward.—Discussion by, 463.

Goethals, George W.—Awarded the John Fritz Medal, 198.

Goldsmith, Clarence. — Discussion by, 413.

Gompers, Samuel.—Letter from, 878.

Goodale, Harry Jocelyn.—Elected an Associate Member, 879.

Goodell, J. M.—Discussion by, 879.

Goodkind, Morris.—Elected an Associate Member, 118.

Goodman, Charles.—Transferred to Grade of Member, 461.

Goriachkovsky, Vladimir.—Address by, 290; Elected a Member, 879.

Gorman, Frank Lee.—Elected a Member, 868.

Gottheim, Irving.—Elected an Associate Member, 869.

"Government War Construction Work in the United States," Address on, 151, 164.

Graham, Dale Janverin.—Elected an Associate Member, 869.

Graham, Roland Russell.—Transferred to Grade of Associate Member, 544.

Grannis, James Kidwell.—Transferred to Grade of Associate Member, 462.

Grathwol, Henry Jacob.—Elected an Associate Member, 874.

Graves, Walter Hayden.—Death announced, 877.

Gray, Bernard Elbert.—Elected an Associate Member, 880.

Gray, Edwin Dwight Allemand.—Elected an Associate Member, 874.

GREEN, FREDERICK WILLIAM.—Transferred to Grade of Member, 882.
GREEN, GROVER CLEVELAND.—Elected an Associate Member, 542.
GREEN, ROY MELVIN.—Elected an Associate Member, 880.
GREENE, CARLETON.—Nominated as Director, 973.
GREENE, FREDERICK STUART. — Appointed State Highway Commissioner for New York, 312; Appoints Deputy State Highway Commissioners, 481.
GREENE, RUSSELL DE COSTA.—Transferred to Grade of Member, 411.
GREENLEAF, DONALD LEAL.—Elected an Associate Member, 880.
GREENOUGH, MAURICE BROWN.—Elected an Associate Member, 869.
GREENWAY, JOHN OWEN.—Transferred to Grade of Member, 871.
GREGORY, JOHN H.—Resignation Accepted, As Member of American Engineering Standards Committee, 126.
GREINER, J. E.—Discussion by, 290; On Committee Appointed to Confer with Committee on Iron and Steel Structures of American Railway Engineering Association, 468.
GREYDANUS, SYTZE ELO.—Elected an Associate Member, 869.
GRIER, ARTHUR JAY.—Elected a Member, 541.
GRIFFIN, E. RAY.—Elected an Associate Member, 542.
GRIFFITH, JAMES RINALDO.—Elected an Associate Member, 537.
GROOTHOFF, ARNOLD.—Elected an Associate Member, 410.
GRUMM, FRED JUSTUS.—Elected an Associate Member, 118.
GRUNSKY, C. E.—Elected a Director, 122, 149; Resolution by, Relative to Publication of Professional Directory of Engineers, 887.
GRUPE, EDGAR YOUNG, JR.—Elected a Junior, 461.
GUEST, JOHN HENRY.—Elected a Junior, 461.
GUEVARA I MORALES, LUIS ALEJANDRE.—Elected an Associate Member, 869.
GUNBY, FRANK MCCLELLAN.—Elected a Member, 536.
GUSTIN, LESTER CARLISLE.—Elected an Associate Member, 537.

HAASIS, CUTHBERT WEAD.—Elected an Associate Member, 410.
HABERLE, EDWARD LOUIS.—Transferred to Grade of Associate Member, 120.
HABICHT, GEORGE CONRAD.—Elected an Associate Member, 869.
HACKENBERG, JAMES OSBERNE.—Elected an Associate Member, 118.
HADWEN, T. L. B.—Appointed to Represent Society on Joint Committee on Culvert Pipe Specifications, 883, 934.
HAEFNER, CARL WILLIAM.—Elected an Associate Member, 869.
HAEHL, H. L.—On Nominating Committee, 116, 128, 134.
Hainaut, Belgium, Province of.—Damage and Reconstruction Work in, 958.
HALCOMBE, NORMAN MARSHALL.—Death announced, 412.
HALE, GEORGE ELLERY.—Honors for, 688.
HALE, HERBERT M.—On Programme Committee for Second Meeting of Each Month, 884, 938.
HALL, JOHN L.—Discussion by, 541, 555, 561.
HALL, JOHN WENDELL.—Elected an Associate Member, 869.
HALL, SAMUEL PRESCOTT.—Elected a Member, 118.
HALPERN, MICHAEL.—Elected an Associate Member, 874.
HALSTEAD, GEORGE ELIAS.—Transferred to Grade of Member, 882.
HAM, ROSCOE CONKLING.—Elected an Associate Member, 542.
HAMLIN, RALPH.—Transferred to Grade of Member, 876.
HAMMEL, EDWARD F.—Discussion by, 795; Transferred to Grade of Member, 882.
HAND, GEORGE TROWBRIDGE.—Elected a Member, 536.
HANGER, KENNETH HARROW.—Elected an Associate Member, 542.
HANNAMAN, DONALD ARMSTRONG.—Elected an Associate Member, 880.

HANNUM, WILLIAM.—Elected an Associate Member, 880.

HANSEL, CHARLES.—Resolution by, Relative to Plan for Financing Work of National Service Committee, 122, 147; Discussion by, 541, 567, 878; Letter from, Relative to Report of Committee on Development, 884, 921; On Sub-Committee on Budget of Committee on Development, 885.

HANSELMAN, WILLIAM LOUIS.—Elected a Junior, 411.

HANSEN, HANS JORGEN.—Elected a Member, 410.

HANSON, FRED ERNEST.—Elected an Associate Member, 537.

HARDEE, WILLIAM JOSEPH.—Death announced, 2.

HARDING, EDWARD CRITTENDEN, JR.—Transferred to Grade of Associate Member, 120.

HARDING, SIDNEY TWICHELL.—Transferred to Grade of Member, 876.

HARDY, HARRY.—Death announced, 796.

HARGIS, ANDREW BROADUS.—Elected an Associate Member, 869.

HARKNESS, ANDREW HARKNESS.—Elected a Member, 541.

HARMAN, JOHN JAMES.—Elected a Member, 460.

HARN, JOHN EDWIN.—Elected a Junior, 537.

HARPER, WALTER R.—Invitation from, to Attend Launching of Ship, *Polias*, 536.

HARRIS, FRANK WILLIAM.—Elected an Associate Member, 537.

HARRISON, RANDOLPH.—Elected an Associate Member, 537.

HARRISSON, GERARDUS.—Elected an Associate Member, 118.

HART, ARTHUR JOHN.—Elected an Associate Member, 874.

HARTMAN, JOHN JAMES.—Elected a Junior, 875.

HARVIE, HENRY.—Elected an Associate Member, 537.

HASTIE, FRANK BOWMAN.—Elected a Junior, 875.

HATT, W. K.—On Joint Committee to Formulate Specifications for Reinforced Concrete, 934.

HATTON, T. C.—Discussion by, 541, 564.

HAUKE, CHARLES ROYCE.—Transferred to Grade of Associate Member, 462.

HAVEN, WILLIAM APPLETON.—Death announced, 120, 144.

HAVENS, HARRY LUCAS.—Elected an Associate Member, 460.

HAVILAND, ARTHUR. — Death announced, 796.

HAWGOOD, HARRY.—Appointed Chairman of Local Committee of Arrangements for 1920 Annual Convention, 887.

HAY, WILLIAM WREN.—Elected an Associate Member, 874.

HAYDEN, FRANK DEMETRIUS.—Transferred to Grade of Member, 538.

HAYDOCK, WINTERS.—Elected a Member, 536.

HAYES, LUKE JOSEPH.—Transferred to Grade of Member, 543.

HAYNES, HARWOOD SYME.—Elected an Associate Member, 542.

HAYS, JAMES B.—Awarded the Collingwood Prize for Juniors, 116, 133; Transferred to Grade of Associate Member, 882.

HAZEN, JOHN VOSE.—Death announced, 877.

HAZLEHURST, JAMES NISBET.—Death announced, 412.

HEARN, RICHARD LANKASTER.—Elected an Associate Member, 537.

HECHMER, CARL ADAM.—Elected a Junior, 875.

HEFFELFINGER, JOHN MILTON, JR.—Transferred to Grade of Associate Member, 882.

HEIDEL, CHARLES SUMNER.—Transferred to Grade of Associate Member, 876.

HEIN, PETER LEO.—Elected an Associate Member, 542.

HEISER, ALFRED BRACKENRIDGE.—Transferred to Grade of Member, 543.

HEISER, WILLIAM JOSEPH.—Transferred to Grade of Associate Member, 876.

HELM, FRANK.—Transferred to Grade of Associate Member, 120.

HENDERSON, JOSEPH NEWCOM.—Elected an Associate Member, 411.

HENDRIE

Hendrie, John Gibson.—Transferred to Grade of Member, 538; Death announced, 796.
Henley, Robert Dwiggins Monteith.—Death announced, 796.
Hennebique, Jules Joseph.—Elected a Member, 536.
Henny, David Christiaan.—Nominated as Director, 973.
Henrici, Frederick William.—Elected a Member, 873.
Henry, John Bernard.—Elected a Junior, 881.
Henry, Wesley Lawrence.—Elected an Associate Member, 869.
Herman, Ralph Emerson, Jr.—Elected an Associate Member, 460.
Herschel, Clemens.—On Committee on Honorary Membership, 682.
Hershey, Joseph William.—Elected a Member, 879.
Hess, John Strider.—Transferred to Grade of Member, 543.
Hesselberger, Milton.—Elected an Associate Member, 411.
Hession, John Henry.—Elected an Associate Member, 542.
Hesterly, Homer Wynne.—Elected an Associate Member, 874.
Hewes, Laurence Ilsley.—Elected a Member, 873.
Heywood, Gene Bryant.—Elected a Junior, 543.
Hicks, John Robert.—Elected a Member, 879.
Hicks, Preston Thomas.—Elected an Associate Member, 542.
Higgs, James Allan, Jr.—Elected an Associate Member, 874.
Hight, William Clarence.—Elected an Associate Member, 411.
Highway Engineering.—Fellowships in, 956.
Highway Construction in Texas.—Statement Relative to, 427.
Highway Engineering, Committee on.—Report of Committee on Special Committees on Appointment of, 545, 687; Appointment of, 884, 993.
Hill, Nicholas S., Jr.—Discussion by, 1.
Hill, Norman Haden.—Elected an Associate Member, 118.
Himes, Albert James.—Death announced, 883.

HITCHCOCK

Hitchcock, Arthur Beers.—Elected an Associate Member, 542.
Hodgdon, Benjamin Alexander.—Transferred to Grade of Member, 119.
Hodgman, Bert Bradley.—Elected a Member, 879.
Hodgson, Carey Vandervort.—Elected a Member, 879.
Hoff, Frank Warne.—Elected an Associate Member, 542.
Hogan, Francis Vincent.—Elected an Associate Member, 874.
Hogg, Thomas Henry.—Elected a Member, 879.
Holborn, Lewis Adams.—Transferred to Grade of Associate Member, 538.
Holland, Arthur Francis.—Elected an Associate Member, 874.
Holland, C. M.—Resignation of, As Member of Committee on Development Accepted, 883.
Holland, Leon Lynwood.—Elected a Member, 879.
Hollister, Solomon Cady.—Elected an Associate Member, 537.
Honeyman, Bruce Ritchie.—Death announced, 2.
Honorary Membership, Committee on.—Resolution of Board of Direction Authorizing Appointment of, 547; Appointment of, 682.
Hoover, Herbert Clark.—Presented with the Washington Award, 13, 198; Account of Dinner to, By American Institute of Mining and Metallurgical Engineers, 954.
Hopkins, Allan Valentine.—Elected a Junior, 881.
Hopkins, John Thomas.—Elected an Associate Member, 542.
Horn, Frank Churchill.—Death announced, 290.
Horton, John William.—Death announced, 121, 144.
House, F. E.—On Local Committee of Arrangements for Annual Convention, 429, 495.
Housing Problem in England.—Statement Relative to, 961.
Hoyt, John Clayton.—Nominated as Director, 973.
Hoyt, W. H.—On Local Committee of Arrangements for Annual Convention, 429, 495.

HSIEH

Hsieh, Ernest Shengtsu.—Elected a Junior, 870.
Hudson, Clarence Walter.—Nominated as Director, 973.
Hudson Tunnel. *See* New York-New Jersey Vehicular Tunnel.
Hughes, Charles Warren.—Elected an Associate Member, 537.
Huie, Irving V. A.—Appointed Deputy State Highway Commissioner of New York, 481.
Hull, William Deloney.—Elected an Associate Member, 411.
Hulsart, C. Raymond.—On Programme Committee for Second Meeting of Each Month, 884, 938.
Humphrey, Richard L.—Discussion by, 541, 557; On Sub-Committee on Budget of Committee on Development, 885.
Hunt, Andrew M.—On Publication Committee, 129; Address by, As Delegate to Joint Engineering Congress, Paris, 189.
Hunt, Charles Warren.—Appointment of, and Resignation of, As Representative of Society on Committee on Technical Symbols, 127; Elected Secretary, 129; On Library Committee, 129; On Committee of Arrangements for Annual Convention, 129, 429, 495; Discussion by, 539, 541, 877, 879; Appointment of, As Representative of Society on Founder Societies' Finance Committee on Joint Activities, 546, 684; On Programme Committee for Second Meeting of Each Month, 884, 938; On Committee of Arrangements for Annual Meeting, 972.
Hunt, Harry Hauver.—Elected an Associate, 881.
Hunt, Horace Sinclair.—Transferred to Grade of Member, 462.
Hunt, Robert W.—Eightieth Birthday Anniversary Celebrated, 10.
Hunt, Rufus Cameron.—Death announced, 289.
Huntley, Lee Harvey.—Elected an Associate Member, 537.
Hussey, Laurence.—Elected an Associate Member, 118.
Hutton, Harold Stephens.—Elected a Junior, 881.

HYDE

Hyde, Charles Gilman.—Appointed Consulting Engineer on Filtration Plant for Sacramento, Cal., 682.

Ibarguen y Pi, Alberto Angel.—Transferred to Grade of Member, 544.
Illinois Association.—Abstract of Minutes of Meetings of, 320, 715.
India, Engineers of.—Movement to Organize Institution of, 813.
Industrial Board of Department of Commerce.—Statement Relative to Organization of, 425.
Information Service, National Legislative and Departmental.—Establishment of, For Engineers, 482, 973.
International Engineering Congress, 1904.—Report of Secretary to Board of Direction Relative to Disposal of Copies of Papers of, 128.
International Railway Congress Association.—Statement Relative to Origin, Work, etc., of, 926.
Interstate Commerce Commission. *See* United States Interstate Commerce Commission.
Iron and Steel Structures, Committee on, Of American Railway Engineering Association.—Appointment of Committee to Confer with, 468.
Irwin, William Clark.—Elected an Associate, 543.
Items of Interest, 3, 172, 299, 418, 469, 681, 797, 926.

Jackson, James Granbery.—Elected a Member, 873.
Jackson, William.—Elected an Associate Member, 880.
Jacobs, Charles Mattathias.—Death announced, 872.
Jacobs, Nathan Bernd.—Transferred to Grade of Associate Member, 462.
Jacobs, Robert Hyde.—Transferred to Grade of Member, 544.
Jacobson, Carl Joseph.—Elected an Associate Member, 869.
Jameson, Robert Olen.—Elected an Associate Member, 411.

JAVA

Java, Engineering Congress, 1920.—Change of Time Announced, 422; Appointment of John R. Freeman to Convey Salutations of Society to, 492.

JAYCOX, THOMAS WILLIAM.—Death announced, 877.

JEME, TIEN YOW.—Death announced, 463, 475.

JENKINS, J. B.—On Committee to Report on Stresses in Railroad Track, 887.

JENNY, LOUIS ALFRED.—Elected an Associate Member, 874.

JENSEN, CHRISTIAN PETER.—Transferred to Grade of Member, 876.

JERVIS, CHARLES MILLER.—Elected an Associate Member, 411.

JESSUP, WALTER EDGAR.—Transferred to Grade of Associate Member, 872.

JEWELL, JOHN LESTER.—Elected an Associate Member, 880.

John Fritz Medal.—Award of, 198, 303; Recipients of, 198, 303; Appointment of Representative of Society on Board of Award of, 887.

JOHNSON, ARTHUR ALBERT.—Elected a Member, 118.

JOHNSON, DAVID TERRILL.—Elected a Junior, 881.

JOHNSON, FRANK ARTHUR.—Elected an Associate Member, 880.

JOHNSON, HAROLD SUCESE.—Elected an Associate Member, 537.

JOHNSON, JOHN MONROE.—Transferred to Grade of Member, 544.

JOHNSON, NATHAN C.—Address by, 289.

JOHNSTON, JOHN WALLACE.—Elected an Associate Member, 542.

Joint Activities, Founder Societies' Finance Committee on.—Resolution Recommending Appointment of, 546; Appointment of, 546, 684; Resolution by, Relative to Appropriation for Work of American Engineering Standards Committee, 884; Resolutions by, Relative to Appropriation for Work of Engineering Societies Employment Bureau and Engineering Council, 886.

Joint Committee on Culvert Pipe Specifications.—Appointment of Representatives of Society on, 883, 934.

JOINT

Joint Committee to Formulate Specifications for Reinforced Concrete.—Appointment of Representatives of Society on, Authorized, 885; Appointment of, 934.

Joint Conference Committee.—Mileage for Members of, 885.

Joint Engineering Congress, Paris, 1918.—Report to Board of Direction Relative to Appointment of Delegates to, By Executive Committee, 125; Action of Board of Direction Relative to Resolutions of Duluth Association on Appointment of Delegates to, 125, 198; Addresses by American Engineering Delegates to, 172; Report of Delegation of American Engineers to, 604.

JOLLEY, HAROLD DEAN.—Elected an Associate Member, 118.

JONES, ALFRED.—Elected an Associate Member, 880.

JONES, CHARLES WEST.—Elected a Junior, 870.

JONES, GRANDVILLE REYNARD.—Death announced, 121, 144.

JONES, LEWIS ALLEN.—Transferred to Grade of Member, 876.

JONES, OWEN ROBERT.—Elected an Associate Member, 880.

JONES, W. N.—On Local Committee of Arrangements for Annual Convention, 429, 495.

Jones-Reavis Bill to Create a National Department of Public Works.—Explanation of, 941.

JORDAN, THOMAS ARTHUR.—Elected a Member, 410.

JORGENSEN, L. R.—Awarded the Norman Medal, 116, 132.

JOY, THOMAS HITCHCOCK.—Elected a Member, 873.

JUNG, JOHN FREDERICK.—Elected an Associate Member, 118.

JUNKERSFELD, PETER.—Elected a Member, 541.

JUST, GEORGE ALEXANDER.—Death announced, 120, 144.

KACKLEY, WALTER JOHN.—Transferred to Grade of Member, 871.

KAHLERT, ERNEST DOUGLAS.—Elected an Associate Member, 869.

KALLASCH, WINFRED MILLER.—Transferred to Grade of Member, 412.
KANE, WALLACE BYRNE.—Elected a Junior, 537.
Kansas City Engineering Society.—Action of Board of Direction on Resolutions by, On Development of Professional Engineering, 466.
KASSEBAUM, FREDERICK WILLIAM, JR.—Transferred to Grade of Member, 538.
KEITH, FRASER S.—Correspondence with, 541, 573, 574.
KEITH, H. C.—Discussion by, 122, 879.
KELLOGG, JOSEPH A.—Appointed New York State Public Service Commissioner, 492.
KELLOGG, NORMAN BENJAMIN.—Death announced, 463.
KELLY, CASSIUS WILLIAM.—Death announced, 2.
KELLY, EDWARD JOSEPH.—Elected a Member, 541.
KELLY, HARRY JOSEPH.—Elected an Associate Member, 869.
KELLY, PRESCOTT VAIL.—Elected an Associate Member, 537.
KEMMLER, EDWARD ALBERT.—Elected a Member, 536.
KETCHUM, MILO S.—On Finance Committee, 129.
KEYS, EDWARD ALLEN.—Transferred to Grade of Member, 871.
KIEL, FRANK BURDETTE.—Elected an Associate Member, 880.
KIMBRELL, GEARY.—Elected an Associate Member, 542.
KINCH, MASON HILL.—Elected a Junior, 881.
KINDRICK, ALPHA HARNEY.—Elected an Associate Member, 874.
KING, FRANK ELMER.—Elected an Associate Member, 880.
KING, MAX WERNER.—Elected a Member, 536.
KING, TAO.—Transferred to Grade of Associate Member, 882.
KING, WALTER JACOB.—Elected an Associate Member, 874.
KINGSLEY, MARVIN WATSON.—Death announced, 123.
KINGSLEY, MOSES LELAND.—Elected a Member, 410.
KINNEAR, LAWRENCE WILSON.—Transferred to Grade of Associate Member, 876.
KINSEY, WILLIAM AMBROSE.—Transferred to Grade of Member, 462.
KIRKHAM, JOHN EDWARD.—Transferred to Grade of Member, 544.
KIRSTEIN, PAUL ROBERT.—Death announced, 462.
KITTREDGE, G. W.—Discussion by, 122.
KNIGHT, ALEXANDER CLINTON.—Elected an Associate Member, 880.
KNISKERN, PHILLIP WHEELER.—Transferred to Grade of Associate Member, 544.
KNOPH, OLAF INGVALD.—Elected a Member, 873.
KNOWLES, CHARLES H.—Death announced, 290.
KNOWLES, JAMES HENRY.—Elected a Member, 873.
KNOWLES, MORRIS.—Discussion by, 413.
KNOX, ROBERT MAURICE.—Elected an Associate Member, 880.
KOCH, OSCAR HENRY.—Elected an Associate Member, 460.
KRAMER, HANS.—Elected a Junior, 881.
KRANZ, HENRY HUGO.—Elected an Associate Member, 880.
KUBITZ, FRITZ.—Elected an Associate Member, 880.
KUCHAR, FRANK MILES.—Transferred to Grade of Associate Member, 120.
KUCHAR, JOSEPH JAROMIR.—Elected a Junior, 543.
KUNZ, GEORGE F.—On Advisory Engineering Committee for New York State, 311.
KUPEC, WILLIAM JOSEPH.—Elected a Junior, 870.
KURTZ, FORD.—Elected a Member, 879.
KYLE, RALPH BRIGGS.—Transferred to Grade of Member, 876.

LABOON, JOHN FRANCIS.—Elected an Associate Member, 460.
Labor, American Federation of.—Resolution by, Relative to Labor and Scientific Research, 696; Letter from President of, 878.
LACY, LESTER HOLCOMB.—Elected an Associate Member, 869.
LAMB, ERNEST AVERY.—Transferred to Grade of Member, 871.

LAMB

Lamb, Sydney Bishop.—Transferred to Grade of Associate Member, 544.
Lambert, Byron James.—Transferred to Grade of Member, 871.
Lamme, Benjamin G.—Awarded the Edison Medal, 690.
Lancaster, William Louis.—Elected a Member, 868.
Lane, Emory Wilson.—Transferred to Grade of Associate Member, 462.
Lane, Franklin K.—Letter of, In Reply to Letter of M. O. Leighton on Completion of Topographic Map of the United States, 487.
Lange, William Herbert.—Elected an Associate Member, 869.
Langfitt, W. C.—Discussion by, 873.
Langthorn, Jacob S.—Elected a Director, 122, 149; On Publication Committee, 129.
Lansdale, John. — Transferred to Grade of Member, 462.
Larkin, Edward Leo.—Elected an Associate Member, 118.
La Rue, Eugene Clyde.—Transferred to Grade of Member, 544.
Latenser, John, Jr.—Elected an Associate Member, 460.
Latey, H. N.—Report to Board of Direction on Appropriation for Work of American Engineering Standards Committee, 884.
Latimer, Claude Alfred.—Transferred to Grade of Associate Member, 876.
Laub, Hermann.—Death announced, 2.
Laurie Prize.—Award of, 116, 133.
La Valle, Peter Francis.—Elected an Associate Member, 118.
Lavis, F.—Discussion by, 409.
Lawson, T. R.—Appointed to Represent Society at Meeting of American Institute of Mining Engineers, 127.
Leaf, James Pinney. — Elected a Member, 460.
League of Red Cross Societies.—Organization of Division of Sanitation of, 939.
Leavenworth, George Stevens.—Death announced, 796.
Lee, Arthur Carl.—Transferred to Grade of Member, 882.

LEE

Lee, Charles Hamilton. — Transferred to Grade of Member, 544.
Lee, Ivy L.—Discussion by, 878.
Lee, Lasley.—Elected an Associate Member, 411.
Leech, Edward.—Elected an Associate Member, 542.
Leighton, M. O.—Discussion by, Of Work of National Service Committee, 121, 146; Letter of, Relative to Completion of Topographic Map of the United States, 422; Reply to Letter of, By Secretary of Interior Relative to Completion of Topographic Map of the United States, 487.
Leister, Simon Hammett.—Elected an Associate Member, 869.
Leng, Horace Greeley.—Elected an Associate Member, 869.
Letts, Joseph Clinton.—Elected an Associate Member, 880.
Levey, Benjamin.—Elected a Junior, 543.
Levine, Harold Julius.—Elected an Associate Member, 537.
Levine, Lionel Montefiore.—Elected an Associate Member, 874.
Lewis, Luther Hammond. — Transferred to Grade of Member, 538.
Lewis, Nelson P.—On Finance Committee, 129; Address by, As Delegate to Joint Engineering Congress, Paris, 191; Presides at Meeting, 409, 459, 463, 539, 795, 867, 878; Address by, 414, 419; Discussion by, 460; Appointment of, As Representative of Society on Founder Societies' Finance Committee on Joint Activities, 546, 684; On Committee on Honorary Membership, 682; On Permanent Franco-American Engineering Committee, 886, 938.
Library Board of United Engineering Society. — Resolutions by, Relative to Recataloguing Engineering Societies Library, 123; Letter from Secretary of, Relative to Books for University of Louvain, 937.
Library Committee.—Appointment of, 129; Report of, To Board of Direction, Relative to Engineering Societies Library, 544, 683.

Library, Engineering Societies.—Accessions to, 43, 221, 330, 437, 507, 729, 833, 992; Resolutions of Library Board of United Engineering Society Relative to Recataloguing of, 123; Resolution of Board of Direction Relative to Recataloguing of, 124; Appropriation for Recataloguing of, Approved by Board of Direction, 544, 681; Report on, Of Library Committee to Board of Direction, 544, 683; Resolution of Board of Direction Relative to Ownership of Books in, 544.

License Committee of Engineering Council.—Statement by, On State Laws for Licensing Engineers, 815.

Licensing of Engineers.—Report of Committee of San Francisco Association on, 6; Engineers' Registration Act for Oregon, 304, 426; Discussion of, By Technical Societies, 479; Registration of Professional Engineers in Oregon, 814; State Laws for, 815; Proposed Registration of Civil Engineers in England, 962.

Lichtenstein, Harry.—Transferred to Grade of Associate Member, 538.

Liddell, Nathaniel Morris.—Elected an Associate Member, 542.

Lindau, A. E.—On Joint Committee to Formulate Specifications for Reinforced Concrete, 934.

Lindley, Edward Searles.—Elected an Associate Member, 411.

Lindsey, Alfred Raymond.—Transferred to Grade of Member, 119.

Linenthal, Mark.—Transferred to Grade of Member, 876.

Little, John Grover.—Elected an Associate Member, 869.

Littlefield, Myron George.—Elected a Member, 868.

Livesay, Henry Gay.—Elected an Associate Member, 874.

Livingston, Homer Bailey.—Elected an Associate Member, 874.

Local Associations.—Report of Committee on Licensing Engineers of the San Francisco Association, 6; Abstract of Minutes of Meetings of, 16, 19, 21, 22, 205, 206, 207, 212, 213, 214, 216, 316, 317, 318, 319, 320, 322, 323, 325, 432, 434, 435, 497, 499, 500, 502, 505, 709, 711, 712, 713, 715, 716, 718, 721, 723, 725, 824, 826, 828, 975, 977, 978, 979, 980, 982, 984, 985, 987; Action by Board of Direction Relative to Resolutions of Duluth Association on Appointment of Delegates to Joint Engineering Congress, Paris, 125, 198; Action by Board of Direction Relative to Resolutions of Duluth Association and Other Associations, On Committee on Development, 125, 200; Resolutions of St. Louis Association Relative to Additional Contributions for Work of National Service Committee, 466; Resolutions of Cleveland Association Relative to Work of Committee on Development, 318, 467; Action of Board of Direction on Resolutions of Cleveland Association Relative to Work of Committee on Development, 467; Action by Southern California Association Relative to Work of Committee on Development, 325, 467; Report to, and Action by, Board of Direction Relative to Action of Southern California Association on Work of Committee on Development, 467; Action by Duluth Association Relative to Adoption by Engineering Council of News Bulletin, 209, 467; Report to, and Action by, Board of Direction Relative to Action of Duluth Association Recommending Adoption by Engineering Council of News Bulletin, 467; Constitution of Connecticut Association Approved, 887, Resolution of San Diego Association Relative to Creation of National Department of Public Works Presented to Board of Direction, 887.

Lockwood, Rex Barnum.—Elected an Associate Member, 460.

Lomax, Nelson Johnson.—Elected an Associate Member, 542.

London, England.—New Tramways for, 964.

LONG, JAMES BLAIR.—Elected an Associate Member, 118.

LONGLEY, FRANCIS F.—Appointed Associate Director of Division of Sanitation of League of Red Cross Societies, 939.

LONGSHORE, RICHARD LIPKEY.—Elected an Associate Member, 118.

LONGWELL, JOHN STALKER.—Transferred to Grade of Associate Member, 538.

LOTTER, HENRY HOWELL.—Elected a Member, 868.

Louvain, University of.—Appeal for Books for, Library of, 937.

LOVERING, HARRY DOUGLAS.—Transferred to Grade of Associate Member, 876.

LOWELL, JOHN WESLEY, JR.—Elected an Associate Member, 119.

LOWETH, C. F.—Discussion by, 541, 563.

LOZIER, WILLIAM SHERMAN.—Elected a Member, 868.

LUCAS, GEORGE L.—On Committee of Arrangements for Annual Meeting, 972.

LUCEY, JOHN.—Elected an Associate Member, 119.

LUHRS, ALBERT WEIGAND.—Elected a Junior, 537.

LUKESH, GUSTAVE RUDOLF.—Elected a Member, 879.

LUSK, CHARLES WINSLOW.—Transferred to Grade of Member, 882.

LYNCH, ALEXANDER SYDNEY.—Transferred to Grade of Member, 119.

LYON, WARREN ADAMS.—Elected an Associate Member, 874.

MACDONALD, CHARLES.—Presides at Meeting, 290.

MACISAAC, F. J.—Discussion by, 868.

MACKAY, ANGUS ROBERT.—Death announced, 462.

MACMILLAN, EDWARD A.—Appointed Instructor in Civil Engineering at Princeton University, 477.

MACMILLAN, JOHN.—Elected a Member, 879.

MACSHEFFRAY, FRANK ALBERT.—Elected an Associate Member, 869.

MCCARTHY, JUSTIN CHARLES.—Elected an Associate Member, 880.

MCCASSY, STANLEY.—Transferred to Grade of Associate Member, 877.

MCCLELLAND, GEORGE W.—Elected a Junior, 461.

MCCLINTOCK, HALLETT EDWARD.—Transferred to Grade of Member, 462.

MCCOMB, DANA QUICK.—Transferred to Grade of Member, 120.

MCCURDY, BYRON CASPER.—Elected a Junior, 543.

MCDONALD, HUNTER.—Discussion by, 541, 561.

MCGEHEARTY, JEROME FRANCIS JOSEPH. — Elected an Associate Member, 880.

MCGREGOR, ROBERT ROY.—Transferred to Grade of Member, 462.

MCHENRY, REYNOLDS.—Elected an Associate Member, 411.

MCKINSTRY, ROSS WALDRON.—Elected a Junior, 875.

MCLINTOCK, ADAM ARTHUR.—Elected an Associate Member, 869.

MCMINN, THOMAS J.—Retires as Assistant Secretary, 313, 464.

MCNALLY, FRANK ANGUS.—Elected an Associate Member, 460.

MCSWEENEY, THOMAS FRANCIS.—Elected a Junior, 537.

MADDEN, CHARLES MICHAEL.—Elected an Associate Member, 869.

MADDEN, JOHN HENRY.—Transferred to Grade of Member, 544.

MADDOCK, THOMAS.—Transferred to Grade of Member, 876.

MAENNER, LUDWIG THEODORE.—Elected a Member, 873.

MAGOR, HENRY BASIL.—Transferred to Grade of Member, 882.

MALVIG, AXEL OSVALD.—Elected an Associate Member, 880.

MANDELL, SOLON BARON.—Elected an Associate Member, 537.

Manitoba, University of.—Announcement Relative to Appointment of Professor of Civil Engineering at, 491.

MANLEY, HENRY.—Death announced, 878.

MANN, C. R.—Report of, On Engineering Education Presented and Accepted as Final Report of Special Committee on Engineering Education, 116, 134; Resolution

Relative to Appointment of Committee to Secure Discussion on Report of, On Engineering Education, 116, 136.

MANNES, ARTHUR SIVERINE.—Elected an Associate Member, 874.

Map, Topographic, of the United States.—Letter of M. O. Leighton Relative to Completion of, 422; Letter of Secretary of Interior in Reply to Letter of M. O. Leighton Relative to Completion of, 487; Resolution of Engineers', Architects' and Constructors' Conference on National Public Works on, 488.

MARDEN, LESLIE ONO.—Elected an Associate Member, 411.

MARKHART, CLARK OBROMELL.—Elected an Associate Member, 119.

MARRIAN, RALPH RICHARDSON.—Death announced, 123.

MARSHALL, LESLIE STANCLIFFE.—Elected an Associate Member, 537.

MARTINEZ, ROLANDO ARNOLDO.—Transferred to Grade of Associate Member, 882.

MARTINEZ Y RENGIFO, CONRADO EUGENIO.—Transferred to Grade of Member, 871.

MARSHALL, RICHARD COKE, JR.—Address by, 151, 164; Elected a Member, 536; Discussion by, 873.

MARSTON, ANSON.—Appointed Representative of Society on Engineering Division of National Research Council, 466, 492, 546; Nominated as Director, 973.

MARX, CHARLES D.—Appointed to Represent Society on Washington Commission of Award, 127; On Committee on Honorary Membership, 682; On Committee of Board of Direction to Review Report of Committee on Development, 885.

MASON, FRANCIS.—On Committee of Arrangements for Annual Meeting, 972.

MASON, G. C.—Discussion by, 541, 567.

MASON, WILLIAM P.—Discussion by, 413.

Massachusetts Institute of Technology.—Endowment Fund for, 815.

MATSON, THOMAS HATCHER.—Death announced, 463.

MATSUMOTO, TORATA.—Elected a Member, 868.

MAULDIN, EARLE.—Elected an Associate Member, 119.

MAURY, DABNEY H.—Paper by, 412; Discussion by, 413.

Meetings of the Society.—Appointment of Programme Committee for, 884, 938.

MEHREN, E. J.—Discussion by, 539, 879.

MELIN, OSCAR WILLIAM.—Transferred to Grade of Associate Member, 877.

Membership.—Additions, 97, 273, 381, 440, 511, 738, 835, 1001; Changes of Address, 382; Reinstatements, 277, 393, 515, 750, 1019; Resignations, 99, 277, 516, 750, 1019; Deaths, 100, 277, 393, 444, 516, 750, 835, 1019; Passes 9 000 Mark, 425; Report of Publication Committee to Board of Direction, Relative to Omission of "Changes of Address" under, 463; Authorization by Board of Direction of Letter-Ballot Relative to Omission of "Changes of Address" under, 463.

Memoirs of Deceased Members.— Request of Publication Committee for, 491.

MERRIAM, CHARLES ALLEN.—Transferred to Grade of Member, 882.

MERRIAM, JUDSON HUNTOON.—Elected a Member, 541.

MERRILL, BERGEN STELLE.—Elected an Associate Member, 874.

MERRILL, O. C.—Discussion by, 877.

Metals, Fatigue of.—Investigation of, 956.

METCALF, LEONARD.—Discussion by, 1; Elected a Vice-President, 122, 149; On Committee on Special Committees, 129; On Committee on Honorary Membership, 682.

METCALFE, HARRY ARTUS.—Elected a Member, 868.

MEYER, CHARLES LOUIS.—Transferred to Grade of Member, 120.

MEYER, GROVER JOHN.—Transferred to Grade of Member, 544.

MIAO

Miao, En-Chao.—Elected a Junior, 538.
Michigan, University of.—Fellowships in Highway Engineering at, 956.
Millard, Allan David.—Elected an Associate Member, 119.
Miller, Albert Arthur.—Elected a Member, 541.
Miller, Alexander Norman.—Transferred to Grade of Member, 120.
Miller, DeMont George.—Elected an Associate Member, 542.
Miller, Karl Andrew.—Transferred to Grade of Associate Member, 120.
Miller, Rudolph P.—On Joint Committee to Formulate Specifications for Reinforced Concrete, 934.
Miller, Spencer.—Address by, 420.
Miller, Walter Edward.—Transferred to Grade of Member, 871.
Miller, Walter Scott.—Elected an Associate Member, 880.
Miller, William Aitken.—Elected an Associate Member, 869.
Milligan, Robert Edgar.—Death announced, 290.
Mills, Adelbert Philo.—Death announced, 2.
Mills, George Clark.—Death announced, 872.
Mills, Vicente.—Elected a Junior, 119.
Minutes of Engineers' Symposium.—Abstract of, 418.
Minutes of Joint Meeting of Founder Societies, to Hear Addresses of Delegates to Joint Engineering Congress, Paris, 172.
Minutes of Meeting of Engineering Division of National Research Council, 3.
Minutes of Meetings of Board of Direction, 123, 128, 129, 291, 463, 465, 468, 883, 888.
Minutes of Meetings of Executive Committee.—Approval of, By Board of Direction, 124, 883.
Minutes of Meetings of Special Committees, 218, 990.
Minutes of Meetings of the Society, 1, 115, 122, 131, 289, 290, 409, 412, 459, 463, 535, 539, 795, 867, 872, 877, 878.

MISSISSIPPI

Mississippi River Commission.—Resolutions of, On Death of Homer Peter Ritter, 697.
Mockler, John Thomas.—Elected an Associate Member, 874.
Modjeski, Ralph.—Elected Honorary President of Society of Polish Engineers and Business Men in America, 427; On Committee to Recommend the Award of Prizes, 546, 684.
Molitor, Frederic.—Discussion by, 878.
Monthly List of Recent Engineering Articles of Interest, 102, 279, 394, 445, 517, 752, 836, 1021.
Moore, James Gates.—Elected an Associate Member, 874.
Moore, Philip N.—Address by, 418.
Moore, Walter, Jr.—Elected an Associate Member, 119.
Moreland, Eldon Wright.—Elected an Associate Member, 869.
Morgan, Thomas Charles.—Transferred to Grade of Associate Member, 877.
Morrell, Ralph Leonard.—Elected a Junior, 881.
Morris, L. V.—Appointed Teller to Canvass Ballot for Officers, 115, 131, 150.
Morris, Samuel Brooks.—Transferred to Grade of Associate Member, 462.
Morris, Thomas Carlyle.—Elected a Member, 879.
Morrison, Arthur Herbert.—Elected an Associate Member, 542.
Morrison, Christopher George.—Transferred to Grade of Member, 412.
Morrison, Henry Prentice.—Death announced, 120, 144.
Morrow, David William.—Elected a Member, 868.
Moss, Robert Edward.—Transferred to Grade of Member, 882.
Moulton, Arthur Garland.—Elected an Associate Member, 461.
Mullins, Joe Burrow.—Elected an Associate Member, 537.
Mullins, Thomas Clinton.—Elected an Associate Member, 119.
"Multiple-Arch Dams on Rush Creek, California," Awarded the Norman Medal, 116, 132.

MUNN

Munn, Harvey Timlow. — Transferred to Grade of Associate Member, 877.

Murray, Joseph Augustine, Jr.— Elected an Associate Member, 119.

Myers, Patrick Henry.—Elected an Associate Member, 537.

Myers, Richard Austin.—Elected an Associate Member, 880.

Nagel, Herbert Lincoln.—Elected an Associate Member, 870.

Nancy, France.—American Firm to Rebuild, 691.

Nash, James Philip.—Elected an Associate Member, 411.

National Board for Jurisdictional Awards in Building Industry.— Organization of, 817.

National Budget System.—Statement Relative to Action of Congress on, 800; Hearing of Engineering Council's Representatives Before National Budget Committee on, 929.

National Department of Public Works. —Appointment of A. S. Baldwin to Represent Society at Conference to Consider Establishment of, 464, 492; Report on Conference Called to Consider Establishment of, 474; Resolution of San Diego Association Relative to Creation of, 887; Action of Engineering Council Relative to Promotion of, 932; Explanation of Jones-Reavis Bill to Create a, 941; Publicity Campaign for, 949.

National Problems.—Voters Urged to Take Responsibility to Solve, 951.

National Research Council.—Minutes of Meeting of Engineering Division of, 3; Report of Patent Committee of, 197; Appointed to Administer Funds, etc., of Research Fellowship in Physics and Chemistry Established by Rockefeller Foundation, 428; Appointment Authorized, and Appointment of, Representatives of Society on Engineering Division of, 466, 492, 546; Aims of Engineering Division of, 476; Honors George Ellery Hale, 688; Appointment to National Research Fellowships in Physics and Chemistry Announced by, 693; Members of Research Fellowship Board Announced by, 694.

National Research Fellowship Board. —Members of, 694.

National Research Fellowships in Physics and Chemistry. — Appointments to Announced, 693.

National Service Committee. — Discussion of Work of, 121, 146; Resolution Relative to Financing Work of, 122, 147; Action of Board of Direction Relative to Request of Engineering Council for Appropriation for Work of, 126; Appointment of A. S. Baldwin to Represent Society at Conference Called by, To Consider Establishment of National Department of Public Works, 464, 492; Prospectus of Work of, Presented to Board of Direction, 464; Resolution of Board of Direction Approving Work of, As Presented in Prospectus, 464; Resolutions of Engineering Council and St. Louis Association Relative to Additional Contributions for Work of, 466; Resolutions of Board of Direction Relative to Request for Additional Contribution for Work of, 466; Report on Conference Called by, To Consider Establishment of National Department of Public Works, 474; Information from, 800, 818, 929; Announcement Relative to Establishment of, 482, 973.

Naval Consulting Board.—Report of Representatives of Society on, 300.

Nebraska Association. — Abstract of Minutes of Meetings of, 19, 212.

Neel, Warren Rabun. — Elected a Member, 536.

Neely, John Burchfield. — Elected a Member, 536.

Neely, Marvin Young.—Elected an Associate Member, 880.

Nelson, J. W.—Appointed Teller to Canvass Ballot for Officers, 115, 131, 150.

Nethercut, Edgar S.—Discussion by, 541, 555.

NEVINS, SEARLE BROWN.—Transferred to Grade of Associate Member, 412.
"New Developments in Concrete," presented and discussed, 289.
New Jersey Interstate Bridge and Tunnel Commission. — Statement Relative to Organization of, and Appointments by, 695,
New Jersey Ship Canal.—Endorsement of Project for, 953.
"New York and New Jersey Vehicular Tunnel." — Informal Discussion on, 409.
New York Meetings Committee.—Approval by Board of Direction of Request of, Relative to Collations at Society Meetings, 129; Name Changed, 884.
New York-New Jersey Vehicular Tunnel.—Statement Relative to Appropriations for, and State Commissions on, 490, 955; Statement Relative to Organization of State Commissions on, 695; Appointment of Engineers of, 695; Members of Board of Consulting Engineers for, 695.
New York State, Advisory Engineering Committee of.—Appointment of, 311.
New York State Bridge and Tunnel Commission. — Members of, 490, 955; Statement Relative to Organization of, and Appointments by, 695.
New York State Highway Commissioner—Appointment of, 312; Appointment of Deputies by, 481.
New York State, Public Service Commission of.—Resolution of Board of Direction Relative to Dismissal of Engineering Employees of, 117, 128, 141, 142; Resolutions of Brooklyn Engineers Club Relative to Dismissal of Engineering Employees of, 128, 141; Reorganization of First District of, 486; Appointment of Lewis Nixon as Commissioner of First District of, 486; Appointment of Joseph A. Kellogg as Commissioner of Second District of, 492.
NEWELL, F. H.—Letter from, Accepted as Progress Report of Special Committee on Regulation of Water Rights, 117, 140.
NEWELL, HARRY EDMUND.—Elected an Associate Member, 870.
NEWMAN, ADELBERT JAMES.—Elected an Associate Member, 874.
NICHOLS, ALLEN EUGENE.—Death announced, 539.
NICHOLS, LEWIS ABEL.—Death announced, 462.
NICHOLS, MARVIN CURTIS.—Elected a Junior, 881.
NICHOLS, THOMAS FLINT.—Elected an Associate Member, 461.
NICKERSON, EDWARD DOUGLAS. — Elected an Associate Member, 119.
NICKEY, EMIT COIN.—Elected an Associate Member, 880.
NICOLAI, N.—Discussion by, 290.
NIGHSWONGER, HARRISON WORTH.—Elected an Associate Member, 537.
NIXON, HARRY STILLWELL. — Elected an Associate Member, 874.
NIXON, LEWIS. — Appointed Public Service Commissioner in New York City, 486.
NOBLE, FREDERICK C.—Discussion on, 879; Letter from, Relative to Report of Committee on Development, 884, 922.
Noble Memorial. *See* Alfred Noble Memorial.
NOETZLI, ALFRED ADOLPH.—Elected an Associate Member, 880.
Nominations, Committee on.—Report of Tellers Appointed to Canvass Final Suggestions for, 116, 128, 133, 134; Presents List of Nominees, 885, 972.
NORCROSS, PAUL H.—Discussion by, 413.
NORDSTROM, EMIL AUGUST.—Elected an Associate Member, 874.
Norman Medal—Award of, 116, 132.
NORRIS, ALEXANDER JOSEPH. — Death announced, 2.
NORRIS, WILLIAM JAMES.—Elected an Associate Member, 880.
NORTH, ALFRED CHANDLER. — Elected an Associate Member, 870.
NORTHAM, MANLEY PEROE. — Transferred to Grade of Member, 462.
NOXON, JAMES ALAN.—Elected a Junior, 119.

OAKES

Oakes, Bethnel Sutherland. — Elected an Associate Member, 537.
Obermeyer, Walter Scott. — Death announced, 462.
Ockerson, J. A.—Letter from, Relative to Eligibility of John W. Alvord for Election as Director, 126; Discussion by, 541, 566.
O'Connor, Francis Barnard. — Elected an Associate Member, 542.
O'Connor, John A.—On Library Committee, 129; On Committee of Board of Direction to Review Report of Committee on Development, 885; Nominated as Director, 973.
O'Donnell, Elwood Aitken.—Elected a Junior, 461.
O'Donnell, J. P.—Appointed to Represent Society at James Watt Centenary, 682.
Officers of the Society.—Appointment of Tellers to Canvass Ballot for, 115, 131; Report of Tellers Appointed to Canvass Ballot for, 122, 149; List of Candidates for, 972.
Ogden, Harold Coe. — Death announced, 2.
Ohio Engineering Society.—Action of Board of Direction on Resolutions by, On Development of Professional Engineering, 466.
Oil Shales, Experimental Work on.—Statement Relative to, 948, 963.
Okazaki, Bunkichi.—Elected a Member, 536.
Okubo, Toshiyuki.—Elected a Junior, 871.
Olds, Albert Roy.—Transferred to Grade of Member, 538.
Olmsted, Homer George. — Elected an Associate Member, 411.
Olson, Luther Emanuel.—Elected a Junior, 881.
Orbeck, Martin J.—Transferred to Grade of Associate Member, 120.
Ordnance Technical Staff.—Organization of, 485.
Oregon.—Engineers' Registration Act for, 304, 426; Registration of Professional Engineers in, 814.
Oren, Fred Bailey.—Elected a Member, 460.

ORGANIZATION

"Organization of Local Association of Members of the Society in New York City District," Informal Discussion on, 539.
Orlian, Israel.—Elected an Associate Member, 870.
O'Rourke, John F.—Discussion by, 409.
Orr, Newell Hamilton.—Elected an Associate Member, 880.
Orr, Scott Wesley.—Elected an Associate Member, 542.
Osborne, Sidney Howard.—Elected a Member, 868.
Osgood, Manley.—Transferred to Grade of Member, 876.
Ostrup, John Christian.—Death announced, 290.
Otis, Wilbur Corthell.—Elected an Associate Member, 411.
Otto, Olaf.—Elected an Associate Member, 542.
Owen, Arthur Edmund.—Transferred to Grade of Member, 871.
Owen, Harvey Skidmore.—Elected an Associate Member, 870.
Owen, Roscoe.—Elected an Associate Member, 870.
Owens, Henry Kinder.—Death announced, 796.

Pace, Ragsdale.—Elected a Junior, 881.
Page, John Marshall.—Elected an Associate Member, 119.
Page, Logan Waller.—Death announced, 2.
Pan-American Financial Conference. —Engineering Representatives in, 946.
Parker, A. F.—Paper by, 463.
Parmley, Walter C.—Discussion by, 409, 463; Presents Paper, 463.
Parsons, H. de B.—On Advisory Engineering Committee for New York State, 311.
Parsons, William Barclay.—Farewell Address of, To Eleventh Engineers, 689; Discussion by, 873.
Patent Committee of National Research Council.—Report of, 197.
Patterson, Charles Arthur.—Elected an Associate Member, 542.
Paul, Charles Edward.—Elected a Member, 536.

PAULI

Pauli, Walter Christian.—Elected an Associate Member, 461.
Pease, James Norman.—Elected a Member, 879.
Peck, Myron Hall.—Death announced, 2.
Peden, Leo Thomas.—Transferred to Grade of Member, 462.
Pegram, George H.—On Committee of Board of Direction to Consider Question of Assistant Secretary, 130; On Committee Appointed to Confer with Committee on Iron and Steel Structures of American Railway Engineering Association, 468; Discussion by, 539, 879; On Committee on Honorary Membership, 682; Presides at Meeting, 877, 878.
Peiser, Fred.—Elected an Associate Member, 461.
Pellissier, George Edward.—Transferred to Grade of Member, 544.
Pennsylvania, Road Building in.—Statement Relative to, 427.
Pennsylvania, School of Engineering in.—Announcement Relative to Establishment of, 817.
Perkins, Frank Edson.—Elected a Member, 536.
Perkins, Locke, McIndoe.—Elected a Member, 868.
Permanent Franco-American Engineering Committee.—Appointment of Members of, 886, 938.
Perrilliat, Arsène.—On Committee to Recommend the Award of Prizes, 546, 684.
Perry, Arthur Irving.—Elected a Member, 460.
Perry, Aubrey Eugene.—Elected a Junior, 871.
Perry, J. P. H.—Discussion by, 795.
Perry, John Edwin.—Elected an Associate Member, 880.
Petheram, George Thomas.—Death announced, 796.
Pfeiffer, Frederic Barringer.—Elected a Junior, 881.
Philadelphia Association.—Communication from F. Herbert Snow to, Relative to the Engineer and the State, 11; Abstract of Minutes of Meetings of, 21, 213, 322, 716, 982.

PHILLIPS

Phillips, Harry John.—Elected an Associate Member, 119.
Phillips, John March.—Elected an Associate Member, 880.
Physics and Chemistry, Research Fellowship in.—Announcement of Establishment of, 428.
"Physiography of Water-Sheds and Channels, and Analysis of Stream Action of Southern California Rivers, with Reference to the Problems of Flood Control", presented and discussed, 872.
Pierce, Leslie Edward.—Elected a Junior, 875.
Pioda, Fernando Charles.—Elected a Junior, 119.
Pipes, Water.—Announcement Relative to Electrical Method for Finding Concealed, 692.
Pistor, George Emil John.—Transferred to Grade of Member, 120.
Pittsburgh Association.—Abstract of Minutes of Meetings of, 22, 434, 984.
Pittsburgh Experiment Station.—Report to Board of Direction on Ceremonies at Dedication of Buildings of, 886, 935.
Plum, Svend Munk.—Elected a Junior, 875.
Plumb Plan for Railroads.—Letter to President Wilson from Council of American Institute of Consulting Engineers Criticizing, 803.
Pohl, Charles A.—Discussion by, 872.
Poland, Republic of.—Prepares for Closer Commercial Relations with the United States, 426.
Polansky, Theodore Arthur.—Elected an Associate Member, 880.
Polias.—Invitation to attend launching of, From Walter R. Harper, 536.
Polish National Department, Commercial and Industrial Bureau of.—Statement Relative to Work of, 427.
Pope, Francis Amory.—Elected a Member, 868.
Porter, H. H.—Appointed Representative of Society on Engineering Division of National Research Council, 466, 492, 546.

PORTER

PORTER, JOHN ENDICOTT.—Transferred to Grade of Member, 876.
Portland Association.—Abstract of Minutes of Meetings of, 502, 718, 828, 985.
POST, ADOLPH JOSEPH.—Transferred to Grade of Associate Member, 538.
POWELL, C. U.—Appointed Teller to Canvass Ballot for Officers, 115, 131, 150.
POWELL, WILLIAM JENNER.—Transferred to Grade of Member, 876.
POWERS, LOUIS.—Transferred to Grade of Associate Member, 882.
PRATT, CAREY SIMON.—Death announced, 2.
PRENTIS, EDMUND ASTLEY, JR.—Elected a Member, 868.
PRICE, WILLIAM EDMUND.—Transferred to Grade of Member, 412.
Price Revolution.—Statement by Irving Fisher Relative to, 483.
PRICHETT, FREDERIC BORRADAILE.—Death announced, 2.
PRIEST, HENRY MALCOLM.—Transferred to Grade of Associate Member, 872.
Princeton University.—Announcement of Appointment of Edward A. MacMillan as Instructor in Civil Engineering at, 477.
Prizes, Committee to Recommend the Award of.—Report of, 116, 127, 132; Appointment Authorized, 468; Appointment of, 546, 684.
Proceedings.—Contributions to, Requested, 431, 495; Report of Publication Committee to Board of Direction Relative to Omission of "Changes of Address" under "Membership" in, 463; Authorization by Board of Direction of Letter-Ballot Relative to Omission of "Changes of Address" under "Membership" in, 463; Request of Publication Committee for Memoirs of Deceased Members for, 491; Report of Secretary to Board of Direction, on Result of Ballot on Omission of "Changes of Address" under "Membership" in, 540, 545, 550; Announcement Relative to Delay in Publication of, 872, 886.

PROGRAMME

Programme Committee for Second Meeting of Each Month.—Appointment of, 884, 938.
PROVAZNIK, WILLIAM JOSEPH.—Elected an Associate Member, 870.
PRUYN, FRANCIS L.—Invitation from, To Inspect Foundations of New Assay Building, 121, 143.
Public Service Commission of New York State. *See* New York State, Public Service Commission of.
Public Works, National Department of.—Appointment of A. S. Baldwin to Represent Society at Conference to Consider Establishment of, 464, 492; Report on Conference Called to Consider Establishment of, 474; Resolution of San Diego Association Relative to Creation of, 887; Action of Engineering Council Relative to Promotion of, 932; Explanation of Jones-Reavis Bill to Create a, 941; Publicity Campaign for, 949.
Public Works Planned for 1919.—Statement Relative to, 196.
Publication Committee. — Appointment of, 129; Request of, Relative to Contributions to, 431, 495; Report of, To Board of Direction, Relative to Changes in Style in Year Book and *Proceedings*, 463; Request of, Relative to Memoirs of Deceased Members, 491; Instructions to, By Board of Direction, Relative to Changes in Year Book and *Proceedings*, 545.
PUFF, CHARLES FREDERICK, JR.—Transferred to Grade of Member, 462.
PUGH, ISAAC WILLIAM.—Elected a Junior, 411.
PUGH, JOSEPH.—Elected an Associate Member, 874.
PURVER, GEORGE M.—Discussion by, 877.
Pyrenees Mountains, Franco-Spanish Tunnel Under.—Statement Relative to Completion of, 311.

QUIMBY, HENRY H.—Discussion by, 795.

RAGSDALE

Ragsdale, Frank Victor.—Elected an Associate Member, 875.
Railroad Statistics for United States. —Statement Relative to, 952.
Railroads, Plumb Plan for.—Letters to President Wilson from Council of American Institute of Consulting Engineers Criticizing, 803.
Railway Engineers, Classification and Compensation of. — Hearings by Board on Wages and Working Conditions of U. S. Railroad Administration on, 494.
Randall, Robert Henry.—Elected an Associate Member, 880.
Randolph, Otto Coffeen Fitz. — Elected an Associate Member, 870.
Rapp, Frank Arthur. — Elected a Member, 541.
Rathjens, George William.—Transferred to Grade of Member, 882.
Ray, George J.—Discussion by, 122.
Reading Room of the Society.—Accessions of Books to the, 509, 999.
Reagan, Earl Frost.—Elected an Associate Member, 542.
Reams, Chatham Coffee.—Elected an Associate Member, 875.
Reconstruction, Committee on. — Report of Committee on Special Committees Recommending Discharge of, 545, 685.
Reconstruction Committees, State.— Statement Relative to Appointment of, and Work of, 477.
Reconstruction Work. — Resolutions Relative to Prosecution of, 121, 145; Addresses by American Engineers Appointed to Aid France in, 172; Report of Delegation of American Engineers Appointed to Aid France in, 604; American Firm to Rebuild Nancy, France, 691; In Belgium, 958; Exhibition of, In France, 960.
Redinger, David Hubbard. — Elected an Associate Member, 870.
Redlich, Carl. — Death announced, 878.
Reilly, Charles Gilbert.—Death announced, 123.
Reitz, Henry George. — Transferred to Grade of Member, 876.
Report of Board of Direction, 27, 116, 124, 131.

REPORT

Report of Committee of Board of Direction to Consider the Matter of Representatives of Society on American Engineering Standards Committee, 127.
Report of Committee of San Francisco Association on Licensing Engineers, 6.
Report of Committee on Alfred Noble Memorial, 117, 140.
Report of Committee on Development of American Society of Civil Engineers, 117, 141, 540, 545, 551, 589, 889; Approval by Board of Direction of Action of Executive Committee Relative to, For Presentation to Annual Convention, 464; Discussion on, 541, 552, 878, 920; Resolution of Board of Direction Relative to Presentation and Distribution of, 545; Resolution of Board of Direction Authorizing Additional Meeting, to Prepare Further, 545; Statement to, and Action by, Board of Direction Relative to Request to Add Explanatory Matter to, 545; Resolution of Board of Direction Authorizing Addition of Explanatory Matter to, 545; Presentation of, with Letters, to Board of Direction, 884; Resolutions of Board of Direction Relative to, 885; Appointment of Committee of Board of Direction to Review, 885; Letters Relative to, 920.
Report of Committee on Engineering Education, 116, 134.
Report of Committee on Nominations to Board of Direction Presenting Names of Nominees, 885.
Report of Committee on Organization of Franco-American Engineering Committee to Board of Direction, 546.
Report of Committee on Publications to Board of Direction Relative to Changes in Style in Year Book and *Proceedings*, 463.
Report of Committee on Regulation of Water Rights, 117, 140.
Report of Committee on Special Committees, 125, 545, 685.
Report of Committee to Codify Present Practice on the Bearing Value of Soils for Foundations, etc., 117, 138.

REPORT

Report of Committee to Recommend the Award of Prizes, 116, 127, 132.

Report of Committee to Report on Stresses in Railroad Track, 117, 139.

Report of Conference on Business Training for Engineers, etc., 421, 491, 698.

Report of Delegation of American Engineers to 1918 Joint Engineering Congress, Paris, 604.

Report of Dr. Mann on Engineering Education.—Presented and Accepted as Final Report of Special Committee on Engineering Education, 116, 134; Resolution Relative to Appointment of Committee to Secure Discussion of, 116, 136.

Report of Finance Committee to Board of Direction, 544, 681.

Report of Library Committee to Board of Direction Relative to Engineering Societies Library, 544, 683.

Report of Meetings of First American Highway Congress, 9.

Report of Organization of Associated General Contractors of America, 9.

Report of Patent Committee of National Research Council, 197.

Report of Representatives of Society on Naval Consulting Board, 300.

Report of Secretary, 40, 116, 131.

Report of Secretary to Board of Direction of Acceptance by H. J. Burt, of Appointment as a Representative of Society on American Engineering Standards Committee, 464.

Report of Secretary to Board of Direction of Acceptance by J. R. Worcester and A. N. Talbot, of Appointment as Representatives of Society on Engineering Council, 464.

Report of Secretary to Board of Direction on Result of Ballot on Proposed Changes in Year Book and *Proceedings*, 540, 545, 550.

Report of Secretary to Board of Direction Relative to Acceptance of Re-election by J. V. Davies as Representative of Society in United Engineering Society, 127.

REPORT

Report of Secretary to Board of Direction Relative to Actions of Founder Societies Finance Committee on Appropriation for Work of Engineering Societies Employment Bureau and Engineering Council, 886.

Report of Secretary to Board of Direction Relative to Alteration of Society House, etc., 125.

Report of Secretary to Board of Direction Relative to Appointment of Delegates to Joint Engineering Congress in Paris by Executive Committee, 125.

Report of Secretary to Board of Direction Relative to Committee on Technical Symbols, 127.

Report of Secretary to Board of Direction Relative to Delay in Publication of *Proceedings*, 886.

Report of Secretary to Board of Direction Relative to Disposal of Copies of Papers of 1904 International Engineering Congress, 128.

Report of Secretary to Board of Direction Relative to Invitation of Society for Promotion of Engineering Education to Appoint Representative to Meeting, 127.

Report of Secretary to Board of Direction Relative to Removal of Model of Alfred Noble Memorial, 466.

Report of Secretary to Board of Direction Relative to Reports of Committee on Setting and Judging Engineering Problems, 124.

Report of Tellers Appointed to Canvass Ballot for Officers, 122, 149.

Report of Tellers Appointed to Canvass Final Suggestions for Nominating Committee, 116, 128, 133, 134.

Report of Treasurer, 42, 116, 132.

Report to, and Action by, Board of Direction on Final Report of Committee on Development, 884.

Report to Board of Direction from Robert A. Cummings on Ceremonies at Dedication of Buildings at Pittsburgh Experiment Station, 886, 935.

Report to Board of Direction on Revised Constitution of American

REPORT

Engineering Standards Committee, 884.
Report to Board of Direction Relative to Action of Duluth Association Recommending Adoption by Engineering Council of News Bulletin, 467.
Report to Board of Direction Relative to Action of Southern California Association on Work of the Committee on Development, 467.
Report to Board of Direction Relative to Resolutions adopted by Library Board of United Engineering Society Recommending Recataloguing of Engineering Societies Library, 123.
Report to Board of Direction Relative to Resolutions of Founder Societies Finance Committee on Appropriation for Work of American Engineering Standards Committee, 886.
Reports of Committee on Establishment of Student Branches of the Society, 124.
REQUARDT, GUSTAV JAEGER.—Transferred to Grade of Member, 882.
Research Fellowship in Physics and Chemistry. — Announcement of Establishment of, 428.
Resolution of American Federation of Labor Relative to Labor and Scientific Research, 696.
Resolution of Board of Direction Approving Work of National Service Committee as Presented in Prospectus, 464.
Resolution of Board of Direction Authorizing Addition of Explanatory Matter to Progress Report of Committee on Development, 545.
Resolution of Board of Direction Authorizing Appointment of Committee on Honorary Membership, 547.
Resolution of Board of Direction Expressing Confidence in Work of Committee on Development, 467.
Resolution of Board of Direction Relative to Appointment of Committee to Consider Question of Assistant Secretary, 130.
Resolution of Board of Direction Relative to Appointment of Mem-

RESOLUTION

bers of Permanent Franco-American Engineering Committee, 886.
Resolution of Board of Direction Relative to Appointment of Representatives of Society on Joint Committee to Formulate Specifications for Reinforced Concrete, 885.
Resolution of Board of Direction Relative to Eligibility to Election as Member of Board, 126.
Resolution of Board of Direction Relative to Mileage of Members of Joint Conference Committee, 885.
Resolution of Board of Direction Relative to Ownership of Books in Engineering Societies Library, 544.
Resolution of Board of Direction Relative to Presentation and Distribution of Progress Report of Committee on Development, 545.
Resolution of Board of Direction Relative to Recataloguing of Engineering Societies Library, 124.
Resolution of Board of Direction Relative to Votes of Trustees of United Engineering Society, 547.
Resolution of Board of Direction Requesting Onward Bates to Continue as Chairman of Committee on Development, 545.
Resolution of C. E. Grunsky on Publication of Professional Directory of Engineers, 887.
Resolution of Engineering Council Relative to Additional Contribution for Work of National Service Committee, 466.
Resolution of Engineers', Architects', and Constructors' Conference on National Public Works on Topographic Mapping of the United States, 488.
Resolution of Founder Societies Finance Committee on Appropriation for Work of American Engineering Standards Committee, 884.
Resolution of San Diego Association Relative to Creation of National Department of Public Works, 887.
Resolution on the Relation of the Engineer to the Future Military Activities of the United States, 873.

RESOLUTION

Resolution Recommending Appointment of Founder Societies Finance Committee on Joint Activities, 546.

Resolution Relative to Appointment of Committee to Secure Discussion of Dr. Mann's Report on Engineering Education, 116, 136.

Resolution Relative to Plan for Financing Work of National Service Committee, 122, 147.

Resolutions of American Engineering Standards Committee on Standardization of Screw Threads, 958.

Resolutions of Board of Direction Relative to Dismissal of Engineering Employees of Public Service Commission, 117, 128, 141, 142.

Resolutions of Board of Direction Relative to Extension of Mortgage on Society House, 125.

Resolutions of Board of Direction Relative to Proposed Purchase of Additional Real Estate by United Engineering Society, 465.

Resolutions of Board of Direction Relative to Report of Committee on Development, 885.

Resolutions of Board of Direction Relative to Request of Engineering Council for Additional Contribution for Work of National Service Committee, 466.

Resolutions of Board of Trustees of United Engineering Society Relative to Report of Finance Committee on Purchase of Additional Real Estate, 465.

Resolutions of Brooklyn Engineers Club Relative to Dismissal of Engineering Employees of Public Service Commission, 128, 141.

Resolutions of Cleveland Association Relative to Work of Committee on Development, 318, 467; Action of Board of Direction on, 467.

Resolutions of Duluth Association on Appointment of Delegates to Joint Engineering Congress, Paris.—Action of Board of Direction Relative to, 125, 198.

Resolutions of Duluth Association on Committee on Development.—Action of Board of Direction Relative to, 125, 200.

RESOLUTIONS

Resolutions of Founder Societies and Engineers' Club on Death of Andrew Carnegie, 813.

Resolutions of Founder Societies Finance Committee on Appropriation for Work of Engineering Societies Employment Bureau and Engineering Council, 886.

Resolutions of Kansas City Engineering Society, Ohio Engineering Society, and Rochester Engineering Society on Development of Professional Engineering. — Action of Board of Direction on, 466.

Resolutions of Library Board of United Engineering Society Relative to Recataloguing Engineering Societies Library, 123.

Resolutions of Mississippi River Commission on Death of Homer Peter Ritter, 697.

Resolutions of St. Louis Association Relative to Additional Contributions for Work of National Service Committee, 466.

Resolutions Relative to the Prosecution of Reconstruction Work, 121, 145.

REYNOLDS, CHARLES HENRY.—Elected an Associate Member, 880.

REYNOLDS, WILLIAM LE ROY.—Transferred to Grade of Member, 462.

RHETT, EDMUND MOORE.—Death announced, 2.

RHODES, ALBERT TAYLOR.—Elected an Associate, 870.

RICE, CLIFTON.—Elected an Associate Member, 542.

RICH, BARZILLAI ALLEN.—Elected a Member, 118.

RICH, MELVIN S. — Transferred to Grade of Member, 871.

RICHARDSON, CLIFFORD. — Discussion by, 460.

RICHARDSON, FRANK EDISON.—Elected an Associate Member, 411.

RICHMOND, JULIAN. — Transferred to Grade of Member, 876.

RICKETTS, ALLAN TOWNSHEND.—Elected a Member, 868.

RIDGWAY, ROBERT. — On Programme Committee for Second Meeting of Each Month, 884, 938.

RIDLEY, CLARENCE EUGENE.—Elected an Associate Member, 537.

RIEGEL

Riegel, Ross Milton.—Transferred to Grade of Member, 871.
Rights, Lewis D.—On Publication Committee, 129; On Committee of Board of Direction to Consider Question of Assistant Secretary, 130; On Committee Appointed to Confer with Committee on Iron and Steel Structures of American Railway Engineering Association, 468; Discussion by, 541, 559, 877, 879; On Committee of Arrangements for Annual Meeting, 972.
Rimbault, Emile Leonard.—Transferred to Grade of Associate Member, 120.
Ritter, Homer Peter.—Death announced, 538; Resolutions of Mississippi River Commission on Death of, 697.
Road Building in Pennsylvania.—Statement Relative to, 427.
Roads.—Legislation on, 478, 950; And Fruit Trees, 693; Army Equipment for Work on, 696; Building Outlook for, 947.
Roberts, Warren Russell.—Elected a Member, 536.
Robertson, Fonzie Eugene.—Transferred to Grade of Associate Member, 882.
Robertson, George Sadtler.—Elected an Associate Member, 870.
Robertson, Louis Wellington.—Elected a Junior, 538.
Robinson, A. W.—Discussion by, 873.
Robinson, Ernest Franklyn.—Transferred to Grade of Member, 462; Discussion by, 873.
Robinson, Ernest Leffert.—Elected an Associate Member, 870.
Robinson, George L.—Discussion by, 1.
Robinson, George Norman.—Elected an Associate Member, 875.
Rochester Engineering Society.—Action of Board of Direction on Resolutions by, On Development of Professional Engineering, 466.
Rockefeller Foundation.—Announces Establishment, In Co-operation with National Research Council, Of Research Fellowship in Physics and Chemistry, 428.

ROESCHLAUB

Roeschlaub, Joseph Michael.—Elected an Associate Member, 542.
Rogow, Sydney.—Elected a Junior, 461.
Roll of Honor, 48, 225, 334; Summary of Society Membership on, 47, 224, 333; Discontinuance of, 429.
Root, William Stanton.—Elected an Associate Member, 119.
Rose, John Gansovertte.—Elected an Associate Member, 461.
Rosencrans, E. J.—Appointed Teller to Canvass Ballot for Officers, 115, 131, 150.
Rosenwald, Jesse.—Elected an Associate Member, 880.
Ross, Blair Arthur.—Transferred to Grade of Associate Member, 877.
Ross, William Claiborne.—Elected an Associate Member, 880.
Roullard, Felix King.—Elected an Associate Member, 875.
Rowe, Donald Hefley.—Transferred to Grade of Associate Member, 877.
Rowland Prize.—Award of, 116, 132.
Rubey, Harry Kelley.—Elected an Associate Member, 875.
Russell, Alexander Allen Macvicar.—Transferred to Grade of Associate Member, 120.
Russell, Herbert Lafayette.—Elected a Member, 118.
Ruth, Edgar Kingsbury.—Transferred to Grade of Member, 544.
Ryan, James Tillman.—Elected an Associate Member, 537.
Ryan, Walter Jackman.—Transferred to Grade of Member, 412.

Sackett, Guy Woodford.—Elected an Associate Member, 875.
Sacramento, Cal.—New Filtration Plant for, 682.
Sadler, Walter Clifford.—Transferred to Grade of Associate Member, 877.
Sage, William Hampden, Jr.—Elected a Member, 868.
St. Louis Association.—Abstract of Minutes of Meetings of, 214, 323, 721; Resolutions of, Relative to Additional Contributions for

SALE

Work of National Service Committee, 466.

SALE, CLARENCE STANLEY.—Elected an Associate Member, 119.

SAMUELSON, BERNHARD MARTIN.—Elected a Member, 410.

SANDERSON, NATHAN HERBERT.—Transferred to Grade of Member, 871.

San Diego Association.—Resolution by, and Relative to Creation of National Department of Public Works, Presented to Board of Direction, 887.

San Diego County, California.—Geology and Ground-Waters of, 947.

SANDQUIST, OSCAR ADOLPH.—Elected an Associate Member, 880.

San Francisco Association.—Report of Committee of, On Licensing Engineers, 6; Abstract of Minutes of Meetings of, 16, 316, 497, 498, 709, 824, 975.

San Francisco, Joint Council of Engineering Societies of.—Announcement by, Relative to Engineers' Service Bureau, 8.

SANO, TOJIRO.—Elected a Member, 873.

SARGENT, GEORGE HENRY.—Elected an Associate Member, 537.

SAUERMAN, HENRY BURGER.—Death announced, 539.

SAUNDERS, GEORGE CROSBY.—Transferred to Grade of Member, 882.

SAVILLE, THORNDIKE.—Elected an Associate Member, 537.

SAWDON, WALLACE ATTERBURY.—Elected an Associate Member, 880.

SAWIN, SANFORD WALES.—Elected an Associate Member, 411.

SAWYER, DONALD HUBBARD.—Transferred to Grade of Member, 882.

SCHARFF, MAURICE ROOS.—Transferred to Grade of Member, 871.

SCHEIDENHELM. F. W.—Awarded the Thomas Fitch Rowland Prize, 116, 132.

SCHILLING, ALEXANDER CHARLES.—Death announced, 290.

SCHMIDT, FRED RUDOLF.—Elected an Associate, 411.

SCHNABEL, WILLIAM CHARLES.—Elected an Associate Member, 880.

SCHOLARSHIPS

Scholarships, Memorial.—Establishment of, By Westinghouse Company, 690.

School of Engineering. — Announcement Relative to Establishment of, In Pennsylvania, 817.

Schools and Universities, Trade and Technical.—War Equipment for, 818, 938.

Schools, Technological, Committee to Prepare Engineering Problems and Judge Competitions for.—Action of Board of Direction Relative to, 124; Report of Committee on Special Committees on, 545, 687.

SCHREIBER, J. MARTIN.—Letter to Board of Direction from, Relative to Work of, and Appropriation for, American Engineering Standards Committee, 126; Report of, To Board of Direction Relative to Appropriation for American Engineering Standards Committee, 884.

SCHULTZ, HAROLD AUGUST HASTRUP. —Death announced, 2.

SCHULTZE, PAUL.—Appointed Deputy State Highway Commissioner of New York, 481.

SCHULZ, EDWARD HUGH.—Elected a Member, 873.

SCHUSSLER, HERMANN FREDERICK AUGUST.—Death announced, 539.

SCHUYLER, WALTER WESLEY.—Transferred to Grade of Associate Member, 882.

SCHWENDENER, KARL DEWITT. — Transferred to Grade of Member, 882.

Screw Threads, Standardization of.—Resolutions of American Engineering Standards Committee on, 952.

SCRUGGS, EDWIN LYLE.—Elected an Associate Member, 461.

SEABROOK, HUGH RAYNER.—Elected an Associate Member, 542.

SEALEY, DAVID ALFRED.—Elected an Associate Member, 870.

SEAMAN, H. B.—Discussion by, 795.

SEAMAN, WILLIAM LAURIE.—Elected a Junior, 875.

SEARS, WILLIAM HATFIELD.—Transferred to Grade of Member, 412.

SECRETARY

Secretary.—Report of, 40, 116, 131; Report of, To Board of Direction Relative to Reports of Committee on Setting and Judging Engineering Problems, 124; Report of, To Board of Direction Relative to Alteration of Society House, etc., 125; Report of, To Board of Direction Relative to Appointment of Delegates to Joint Engineering Congress in Paris, by Executive Committee, 125; Report of, To Board of Direction Relative to Acceptance of the Reelection of J. V. Davies as Representative of Society in United Engineering Society, 127; Report of, To Board of Direction Relative to Invitation of Society for Promotion of Engineering Education to Appoint Representative of Society to Meeting, 127; Report of, To Board of Direction Relative to Committee on Technical Symbols, 127; Report of, To Board of Direction Relative to Disposal of Copies of Papers of 1904 International Engineering Congress, 128; Election of, 129; Statement by, To Board of Direction Relative to Work of Office, 130; Statement by, Relative to Work of Delegation of American Engineers to Joint Engineering Congress, Paris, 172; Letter of, To Governors of States Relative to Engineering Societies Employment Bureau, 302; Report of, To Board of Direction, of Acceptance by J. R. Worcester and A. N. Talbot of Appointment as Representatives of Society on Engineering Council, 464; Report of, To Board of Direction, of Acceptance by H. J. Burt, of Appointment as a Representative of Society on American Engineering Standards Committee, 464; Report of, To Board of Direction, Relative to Removal of Model of Alfred Noble Memorial, 466; Report of, To Board of Direction, On Result of Ballot on Proposed Changes in Year Book and *Proceedings*, 540, 545, 550; Announces Election and Transfer of

SECRETARY

Candidates for Membership, 540, 551; Presents Report of Committee on Development, 540, 551; Report of, To Board of Direction, Relative to Appointment of Representatives of Society on Joint Committee on Culvert Pipe Specifications, 883; Report of, To Board of Direction on Adoption of Resolutions by Founder Societies Finance Committee, 884; Report of, To Board of Direction Relative to Delay in Publication of *Proceedings*, 886; Report of, To Board of Direction Relative to Action of Founder Societies Finance Committee on Appropriation for Work of Engineering Societies Employment Bureau and Engineering Council, 886.

Secretary, Assistant.—Resolution of Board of Direction Relative to Appointment of Committee to Consider Question of, 130; Appointment of Committee to Consider Question of, 130; Appointment of, 313; Report to Board of Direction Relative to Election of Stephen L. Coles as, and the Retirement of Thomas J. McMinnas, 464.

"Sewage and Wastes Disposal for the United States Army", Address on, 1.

Seymour, Edwin Newburger.—Elected a Junior, 543.

Shaffer, Nathaniel Leonard.—Elected a Junior, 461.

Shank, Jacob Ralph.—Elected an Associate Member, 543.

Shankland, Ralph Graham.—Transferred to Grade of Member, 412.

Shea, William James.—Elected an Associate Member, 537.

Sheets, Frank Thomas.—Elected an Associate Member, 461.

Shenehon, F. C.—On Local Committee of Arrangements for Annual Convention, 429, 495; Address by, 540, 550, 580.

Shipley, Robert Earle.—Death announced, 2.

Shiraishi, Naoji.—Death announced. 539.

SHLESSINGER

Shlessinger, Jacob.—Elected an Associate Member, 880.
Shumaker, John Perry.—Elected a Junior, 119.
Shupe, Elmer Byron.—Elected a Junior, 875.
Siberian Railway, Technical and Military Boards of.—Members of, 428.
Siebert, Christian Ludewig. — Elected an Associate Member, 461.
Siems, George Henry.—Elected an Associate Member, 875.
Siems, Velentine Bernard.—Elected an Associate Member, 880.
Sigmund, Benjamin Joseph.—Elected an Associate Member, 461.
Silver, Ralph Lawrence. — Elected an Associate Member, 870.
Simmons, Edward Alfred.—Elected an Associate, 875.
Simonds, Fred Washburn.—Elected an Associate Member, 870.
Sinclair, Leonard Hanscome. — Transferred to Grade of Associate Member, 538.
Singh, Kirpal.—Elected an Associate Member, 543.
Singstad, Ole.—Elected an Associate Member, 119.
Sivaslian, Hyrand Arakel.—Elected an Associate Member, 119.
Slater, W. A.—On Joint Committee to Formulate Specifications for Reinforced Concrete, 934.
Slifer, Hiram Joseph.—Death announced, 289.
Slocum, Curlys Lyon.—Transferred to Grade of Member, 544.
Small, James Hampden, Jr.—Transferred to Grade of Member, 462.
Smead, Raphael Chart.—Death announced, 883.
Smillie, Ralph. — Transferred to Grade of Associate Member, 872.
Smith, Acheson.—Elected a Member, 118.
Smith, Augustus. — Discussion by, 122.
Smith, Benjamin Le Compte. — Elected an Associate Member, 870.
Smith, Cedric Burnett.—Elected an Associate Member, 870.

SMITH

Smith, Erwin Weir.—Elected an Associate Member, 119.
Smith, Herschel C.—Transferred to Grade of Associate Member, 877.
Smith, Hilmer Frederick.—Elected an Associate Member, 880.
Smith, J. Waldo.—Presides at Meeting, 1; Discussion by, 413, 795.
Smith, James Axtell.—Elected an Associate Member, 870.
Smith, Julian Polk.—Elected an Associate Member, 875.
Smith, Maxwell Waide. — Transferred to Grade of Member, 871.
Smith, Ralph Adams. — Elected a Junior, 881.
Smith, Roscoe Lee.—Elected an Associate Member, 411.
Smith, Stanley.—Elected an Associate Member, 880.
Smith, William Durkee. — Transferred to Grade of Associate Member, 544.
Smith, Willis Roswell.—Death announced, 2.
Snow, F. Herbert.—Communication from, To Philadelphia Association, Relative to the Engineer and the State, 11.
Snyder, F. A.—Discussion by, 873, 879.
Snyder, George D.—Discussion by, 409, 873.
Society, Deceased Members of.—Request of Publication Committee for Memoirs of, 491.
Society for Promotion of Engineering Education. — Appointment of Representative of Society to Meeting of, 127.
Society, Honorary Membership in the. —Resolution of Board of Direction Authorizing Appointment of Committee on, 547; Appointment of Committee on, 682.
Society House.—Resolutions Adopted by Board of Direction Relative to Extension of Mortgage on, 125; Report of Secretary to Board of Direction Relative to Alteration of, 125.
Society Meetings. — Approval by Board of Direction of Request of New York Meetings Committee Relative to Collations at, 129; Appointment of Programme Committee for, 884, 938.

SOCIETY

Society of Polish Engineers and Business Men in America.—Organization of, For Closer Commercial Relations between the Republic of Poland and the United States, 426.

Society, Officers of the.—Appointment of Tellers to Canvass Ballot for, 115, 131; Report of Tellers Appointed to Canvass Ballot for, 122, 149; List of Candidates for, 972.

Society, Reading Room of the.—Accessions of Books to the, 509, 999.

Society, Student Branches of the.—Majority and Minority Reports of Committee on Establishment of, 124; Action by Board of Direction Relative to Establishment of, 124.

Soils for Foundations, etc., Special Committee to Codify Present Practice on Bearing Value of.—Progress Report of, 117, 138; Minutes of Meeting of, 218, 990; Report of Committee on Special Committees on Work of, 545, 685.

Sonderegger, A. L.—Paper by, 872.

Sopp, Claude Wellington.—Elected a Junior, 543.

Sorzano, Carlos Tejada.—Elected an Associate Member, 537.

Southern California Association. — Abstract of Minutes of Meetings of, 325, 435, 505, 723, 987; Action by, Relative to Work of Committee on Development, 325, 467; Report to, and Action by, Board of Direction Relative to Action of, On Work of Committee on Development, 467.

Spear, William Howard. — Elected an Associate Member, 880.

Speed, William.—Elected an Associate Member, 880.

Speidel, Hugo S.—Death announced, 796.

Speir, Oswald, Jr. — Elected a Junior, 875.

Sperry, Austin Russell Willard.—Death announced, 121, 144.

Spilsbury, E. Gybbon.—Address by, As Delegate to Joint Engineering Congress, Paris, 180.

Spokane Engineering and Technical Association. — Invitation from, To Members of National Engineering Societies Visiting Spokane, Wash., 484.

SPRAGUE

Sprague, N. S. — On Nominating Committee, 116, 128, 133, 134.

Stanfield, Adrian Clyde.—Elected an Associate Member, 543.

Staniford, Charles W. — Awarded the James Laurie Prize, 116, 133.

Stanley, Lloyd Lawrence.—Elected an Associate Member, 411.

Stanton, Fred Caswell.—Death announced, 123.

Stanton, Thomas Elwood, Jr. — Elected an Associate Member, 119.

Stanton, William Macy. — Elected an Associate Member, 880.

Stape, George Philip Alexander.—Elected an Associate Member, 461.

State Reconstruction Committees.—Statement Relative to Appointment of, and Work of, 477.

Stauffen, Frederick Charles. — Elected an Associate Member, 875.

Stauffer, Isaac Yost.—Transferred to Grade of Associate Member, 538.

Stearns, Fred Le Roy.—Transferred to Grade of Associate Member, 538.

Stearns, Frederic Pike.—Death announced, 883.

Stein, Benjamin.—Elected an Associate Member, 543.

Stein, Milton Frederick. — Transferred to Grade of Member, 871.

Steinberg, Max. — Transferred to Grade of Associate Member, 120.

Steinbruch, Walter. — Transferred to Grade of Associate Member, 872.

Stephens, George Hippesley Stanley.—Death announced, 796.

Sterling, Paul.—Elected a Member, 536.

Stern, E. W.—Discussion by, 460, 879.

Stevens, George M. — Death announced, 413.

Stevens, Horace E.—On Local Committee of Arrangements for Annual Convention, 429, 495.

STEVENS, HOWARD E.—On Local Committee of Arrangements for Annual Convention, 429, 495.

STEVENS, JOHN F.—Appointed President of Technical Commission on Siberian Railway, 428.

STEVENS, LEONARD JACKSON.—Elected an Associate Member, 875.

STEVENSON, ALBERT LESLIE.—Elected an Associate Member, 461.

STEVENSON, JAMES CUMMIN.—Transferred to Grade of Member, 871.

STEWART, WILLIAM HENRY.—Elected an Associate Member, 875.

STILLWELL, L. B.—Address by, As Delegate to Joint Engineering Congress, Paris, 184; On Advisory Engineering Committee for New York State, 311.

STIMSON, BURT. — Death announced, 539.

STIVERS, ARTHUR DUCAT. — Transferred to Grade of Member, 882.

STOCKER, LESLIE WRIGHTSON.—Transferred to Grade of Member, 544.

STOCKWELL, HARRY DAVID.—Elected a Junior, 875.

STODDARD, LEWIS MALCOLM.—Elected a Member, 410.

STONE, HENRY MORTON.—Death announced, 123.

STOUT, BENJAMIN ELLIS WARREN.—Elected an Associate Member, 119.

STRACHAN, JOSEPH JOSLIN. — Transferred to Grade of Associate Member, 538.

STRATTMAN, CHARLES ROBERT. — Elected an Associate Member, 881.

Stresses in Railroad Track, Special Committee to Report on.—Progress Report of, 117, 139; Report of Committee on Special Committees on Work of, 545, 686; Appointment of Additional Members of, 887; Minutes of Meeting of, 991.

STUART, FRANCIS LEE.—Paper by, 122; Discussion by, 122, 877, 879; Nominated as Vice-President, 972.

Student Branches of the Society.—Majority and Minority Reports of Committee on Establishment of, 124; Action by Board of Direction Relative to Establishment of, 124.

STUPP, JOHN GEORGE. — Transferred to Grade of Associate Member, 877.

SULLIVAN, JOHN MARTIN.—Elected a Member, 868.

SULLIVAN, MAURICE JOSEPH.—Transferred to Grade of Member, 412.

SUMNER, CHARLES RICHARD.—Elected a Member, 460.

SWAREN, JOHN WILLIAM. — Transferred to Grade of Member, 462.

SWAIN, GEORGE F. — Appointed to Represent Society at Meeting of Society for Promotion of Engineering Education, 127; Address by, As Delegate to Joint Engineering Congress, Paris, 173; Discussion by, 541, 558; On Permanent Franco-American Engineering Committee, 886, 938.

SWENSSON, EMIL.—Death announced, 539.

SWOPE, ERNEST ELBA. — Elected an Associate Member, 543.

SYKES, GEORGE. — Transferred to Grade of Member, 538; Death announced, 796.

SYLLIAASEN, MELVIN OLIVER.—Transferred to Grade of Associate Member, 882.

Symbols, Technical, Committee on.—Action of Board of Direction Relative to Appointment of Representative of Society on, and Appropriation for, 127.

TALBOT, ARTHUR N.—Presides at Meeting, 115, 131; Address by, 116, 131; Appointed as Representative of Society on Engineering Council, 125, 464; Discussion by, 541, 572; On Committee on Honorary Membership, 682.

TALBOT, KENNETH HAMMET.—Transferred to Grade of Associate Member, 412.

TALBOT, LYMAN ROBERT.—Elected an Associate Member, 537.

TAMMEN, HENRY CASPER.—Transferred to Grade of Member, 876.

TARDIEU, ANDRE.—Statement by, Relative to French War Losses, 963.

TARR, CHARLES WINTHROP.—Transferred to Grade of Member, 412.

TARTT, PHILLIPS BRANCH.—Elected a Junior, 871.

TAY

TAY, SAMUEL WRIGHT.—Transferred to Grade of Member, 544.

TAYLOR, FREDERIC JACKSON.—Elected a Member, 873.

TAYLOR, MARCUS PREVOST.—Elected an Associate Member, 537.

TAYLOR, ORVILLE HEBER.—Elected an Associate Member, 870.

TCHIKOFF, VALENTINE VASILIEVICH.—Elected an Associate Member, 870.

TEBBETS, JAMES HARGRAVES.—Elected an Associate Member, 461.

Technical and Trade Schools and Universities. — War Equipment for, 818, 938.

Technical Symbols, Committee on.—Action of Board of Direction Relative to Appointment of Representative of Society on, and Appropriation for, 127.

Tellers.—Appointment of, To Canvass Ballot for Officers, 115, 131; Report of, On Final Suggestions for Nominating Committee, 116, 128, 133, 134; Report of, On Ballot for Officers, 122, 149.

TERRELL, DANIEL VOIERS.—Elected an Associate Member, 119.

Texas Association.—Abstract of Minutes of Meetings of, 216, 725.

Texas, Highway Construction in.—Statement Relative to, 427.

"The American Soldier", Address on, 292.

"The Civic Responsibilities of the Engineer", Address on, 418.

"The Compensation of Engineers", Discussion on, 877.

"The East Canyon Creek Dam", presented and discussed, 463.

"The Engineer and the State", Communication from F. Herbert Snow to Philadelphia Association Relative to, 11.

"The Engineer in His Relation to Administration", Address on, 414, 419.

"The Engineering Alliance — Some Future Developments in Engineering as Seen from a Highway Standpoint", Address on, 459.

"The National Railroad Situation of To-day and a Suggested Basis for Legislation", presented and discussed, 122.

THE

"The Need for a National Department of Public Works", Discussion on, 867.

"The Proposed Nationalization of Railroads in the United States", Discussion on, 878.

"The Reconstruction of the Stony River Dam", Awarded the Thomas Fitch Rowland Prize, 116, 132.

"The Relation of the Engineer to Legislation", Address on, 419.

"The Relation of the Engineer to Production and Distribution", Address on, 420.

"The Relation of the Engineer to Public Opinion", Address on, 420.

"The Relation of the Engineer to the Future Military Activities of the United States", Discussion on, 873; Resolution on, 873.

THIAN, P. E.—On Local Committee of Arrangements for Annual Convention, 429, 495.

THOMAS, CHARLES DURA.—Transferred to Grade of Member, 876; Discussion by, 877.

THOMAS, R. D.—On Local Committee of Arrangements for Annual Convention, 429, 495; Presides at Meeting, 540, 548.

THOMPSON, MISSAC.—Elected a Junior, 543.

THOMPSON, S. E.—On Joint Committee to Formulate Specifications for Reinforced Concrete, 934.

THOMPSON, SAMUEL HYDE.—Elected a Junior, 875.

THOMPSON, W. G. B.—Address by, 459; Discussion by, 460.

THOMSON, T. KENNARD.—Invitation from, To Inspect Foundations of New Assay Building, 121, 143; Discussion by, 122, 290, 409, 413, 539, 795, 872.

THURSTON, E. T.—Discussion by, 413, 460, 539.

TIETZEL, ALBERT MICHAEL.—Elected a Junior, 411.

TILLOTSON, LUTHER RUDOLPH.—Elected an Associate Member, 543.

TILLSON, GEORGE W.—Address by, As Delegate to Joint Engineering Congress, Paris, 177; On Committee on Highway Engineering, 884.

TILTON, GEORGE ALBERT.—Transferred to Grade of Associate Member, 544.
TIMMERMAN, WAYNE EDWARD.—Elected a Junior, 875.
TINGLEY, FRANCIS.—Transferred to Grade of Associate Member, 462.
TINKER, GEORGE S.—Appointed to Represent Society on Joint Committee on Culvert Pipe Specifications, 883, 934.
TINKHAM, S. EVERETT. — Discussion by, 541, 554.
TOBY, MAURICE.—Elected an Associate Member, 881.
TOMKINS, CALVIN.—Discussion by, 122, 409, 460.
TOMS, JAY WILLIAM.—Death announced, 290.
Topographic Map of the United States.—Letter of M. O. Leighton Relative to Completion of, 422; Letter of Secretary of Interior in Reply to Letter of M. O. Leighton Relative to Completion of, 487; Resolution of Engineers', Architects,' and Constructors' Conference on National Public Works on, 488.
TORRALBAS, RAFAEL JOAQUIN.—Death announced, 539.
Town Planning.—Information Relative to, Belgian, 960; Statement Relative to, In England, 963.
TOWNLEY, CALVERT.—Address by, 419.
TOWNSEND, DARWIN WADSWORTH.—Elected an Associate Member, 881.
TOWNSEND, JOSEPH BOYER.—Elected a Member, 536.
Townsend National Highways Bill.—Statement Relative to, 950.
Trade and Technical Schools and Universities. — War Equipment for, 818.
Transactions.—Sale of, 684.
Transactions, 1918.—Statement Relative to Mailing of, 195.
TRASK, CLARENCE HENRY.—Elected an Associate Member, 119.
TRASK, GEORGE FRANCIS DONNELL.—Elected a Member, 868.
TRASK, WARREN DUDLEY.—Elected an Associate Member, 411.
Treasurer.—Report of, 42, 116, 132.
TRIANA, JORGE.—Elected a Junior, 411.
TRIBUS, L. L.—Discussion by, 879.
TRIMBLE, EARLE JAMES.—Elected an Associate Member, 875.
TRINKAUS, WILLIAM HENRY.—Elected an Associate Member, 119.
TRUSCOTT, STARR.—Transferred to Grade of Member, 871.
TSAI, PING YE.—Elected an Associate Member, 875.
TUFEL, JOHN HENRY.—Elected a Member, 868.
"Tunnel Work on Sections 8, 9, 10, and 11, Broadway-Lexington Avenue Subway, New York City", Awarded the J. James R. Croes Medal, 116, 132.
TURNER, D. L.—Discussion by, 539, 879.
TUTTLE, ARTHUR S.—Elected Treasurer, 122, 149; On Committee on Special Committees, 129; Letter from, As Chairman of Engineering Council's Committee on Classification and Compensation of Engineers, 797; Discussion by, 877; Nominated as Treasurer, 972.
TWITTY, JOSEPH JONES.—Elected a Junior, 875.
TYLER, JAMES.—Elected an Associate Member, 411.
TYNDALL, ARTHUR.—Elected an Associate Member, 411.

UHLIG, CARL.—Death announced, 539.
UNGER, WILLIAM LOUIS.—Transferred to Grade of Associate Member, 882.
United Engineering Society.—Resolutions of Library Board of, Relative to Recataloguing Engineering Societies Library, 123; Re-Election of Representative of Society in, 127; Extracts from 1918 Annual Report of Treasurer of, 299; Resolutions of, Relative to Report of Finance Committee on Purchase of Additional Real Estate, 465; Resolutions of Board of Direction Relative to the Proposed Purchase of Additional Real Estate by, 465; Request by, For Appropriation for Use of Engineering Societies Em-

UNITED

ployment Bureau, 546; Resolution of Board of Direction Relative to Votes of Trustees of, 547.

United States.—Reasons of, For Entering War, 816.

United States Army, Committee on Classification of Personnel in.—Statement Relative to Exhibit of Work of, 310.

United States Bureau of Mines.—Report to Board of Direction by Robert A. Cummings, On Ceremonies at Dedication of New Buildings at Pittsburgh Experiment Station, 886, 935.

United States Bureau of Standards.—Technical News Bulletin of, 948.

United States, Chamber of Commerce of.—Election of Engineering Council as Member of, 930.

United States Coast and Geodetic Survey.—Estimated Appropriation for Work of, 940.

United States Congress, 66th.—First Deficiency Appropriation Bill for, 940.

United States Consular Service.—Technical Men Wanted for, 951.

United States Department of Commerce.—Statement Relative to Organization of Industrial Board of, 425.

United States Engineers, Corps of.—Reorganization of, Under Proposed Army Reorganization Bill, 800; Work of, In France, 809.

United States Interstate Commerce Commission.—New Chairman Elected, 428; Letter from Chairman of Engineering Council to President Wilson Urging Appointment of Engineer on, 801.

United States, Military Activities of the, And the Engineer.—Resolution Relative to, 873.

United States Ordnance Department.—Organization of Technical Staff for, 485.

United States Patent Office.—Proposed Legislation for, 690.

United States, President of.—Letter to, From Chairman of Engineering Council Urging Appointment of Engineer on Interstate Commerce Commission, 801; Letter to, From Council of American

UNITED

Institute of Consulting Engineers Criticizing Plumb Plan for Railroads, 803.

United States Railroad Administration.—Hearing by Board on Wages and Working Conditions of, Relative to the Classification and Compensation of Railway Engineers, 494.

United States, Railroad Statistics of.—Statement Relative to, 952.

United States, Secretary of War.—Announces Official Designation for World War, 965.

United States, Topographic Map of.—Letter of M. O. Leighton Relative to Completion of, 422; Letter of Secretary of Interior in Reply to Letter of M. O. Leighton Relative to Completion of, 487; Resolution of Engineers', Architects', and Constructors' Conference on National Public Works on, 488.

United States Treasury Department.—Statement from, Urging Thrift, 808.

Universities and Schools, Trade and Technical.—War Equipment for, 818, 938.

"Unusual Coffer Dam for 1000-Foot Pier, New York City", Awarded the James Laurie Prize, 116, 133.

VAIDEN, COWLES MEAD.—Elected an Associate Member, 411.

VAN AMBURGH, CHARLES.—Appointed Deputy State Highway Commissioner of New York, 481.

VAN CLEVE, HORATIO PHILLIPS.—Elected a Member, 868.

VAN DYKE, CHARLES WILLIAM.—Elected a Junior, 871.

VAN EENENAAM, CORNELIUS.—Elected a Junior, 411.

VAN RENSSELAER, ALLEN.—Transferred to Grade of Member, 882.

VAN SISE, ANDREW JACKSON.—Transferred to Grade of Associate Member, 120.

VAN TRUMP, SAMUEL NEWBOLD.—Elected an Associate Member, 119.

VARNEY, EDWARD ALLEN.—Elected a Junior, 881.

VAUGHAN, HENRY FRIEZE. — Transferred to Grade of Associate Member, 872.
VAWTER, JOHN TERRELL.—Elected a Member, 410.
VEATCH, FRANCIS MONTGOMERY. — Transferred to Grade of Associate Member, 462.
VEATCH, NATHAN THOMAS, JR.— Transferred to Grade of Member, 120.
Versailles, France.—Statement Relative to American Independence Room at, 962.
VEST, JAMES MARSHALL.—Elected a Member, 873.
VICKERS, PAUL AMOS. — Elected a Junior, 543.
VINNEDGE, GEORGE ESPY.—Elected a Member, 873.
VOGEL, JOHN LEONARD.—Transferred to Grade of Member, 120.
VON ZUBEN, FRANCIS JOSEPH. — Elected an Associate Member, 870.
VOSKA, ANTHONY GEORGE. — Elected a Junior, 876.
Voters' Responsibility to Solve National Problems. — Statement Relative to, 951.
Vulcan Steel Products Company.— Signs Contract to Rebuild Nancy, France, 691.

WACHTER, RICHARD EMIL.—Elected an Associate Member, 870.
WADDELL, J. A. L.—Discussion by, 795.
WADHAMS, MOSES ALLYN. — Elected an Associate Member, 875.
WAGEN, JACOB CHARLES.—Elected an Associate Member, 870.
Wages and Working Conditions, Board on, of U. S. Railroad Administration. — Hearing by, On Classification and Compensation of Railway Engineers, 494.
WAGNER, EDWARD LAWRENCE. — Elected a Member, 460.
WAGNER, SAMUEL T.—On Publication Committee, 129; On Committee of Board of Direction to Consider Question of Assistant, Secretary, 130; On Committee of Board of Direction to Review Report of Committee on Development, 885.
WAIT, B. H.—Appointed Teller to Canvass Ballot for Officers, 115, 131, 150.
WALKER, EDSON OZRO. — Elected an Associate Member, 881.
WALKER, FRANK RABOLD.—Elected an Associate, 543.
WALKER, PHILIP BANGS.—Elected an Associate Member, 875.
WALKER, ROBERT YULE.—Transferred to Grade of Associate Member, 120.
WALKER, ROY OLLIN. — Elected an Associate Member, 543.
WALKER, W. T.—On Local Committee of Arrangements for Annual Convention, 429, 495.
WALL, E. E.—On Committee of Arrangements for Annual Convention, 129, 429, 495.
WALLIS, RICHARD PARKER.—Elected an Associate Member, 543.
WALSH, MALCOLM.—Elected a Junior, 876.
WALTER, LLOYD DE WITT.—Elected an Associate Member, 543.
WARE, SAMUEL HOUSTON.—Elected an Associate Member, 537.
WARING, FREDERICK HOLMAN. — Transferred to Grade of Associate Member, 872.
WARKELY, JOHN CROSWELL.—Transferred to Grade of Associate Member, 877.
WARREN, ALBERT KENDALL.—Elected an Associate Member, 881.
WASHINGTON, WALTER OWEN.—Transferred to Grade of Member, 871.
Washington Commission of Award.— Announcement Relative to, 13; Appointment of Representative of Society on, 127; Statement Relative to Organization of, and Presentation of, 197.
Water Rights, Special Committee on Regulation of.—Progress Report of, 117, 140; Report of Committee on Special Committees on Work of, 545, 686.
"Water Supply at Camps and Cantonments and Other Government Enterprises", Address on, 412.
WATERS, W. L.—Discussion by, 878.
WATSON, GEORGE LINTON. — Transferred to Grade of Member, 882.

WATSON, LEON HEATHMAN.—Elected a Junior, 881.
WATSON, MARTIN WALLACE.—Elected an Associate Member, 119.
Watt, James, Centenary.—Appointment of Representative of Society at, 682.
WAY, WILLIAM FLOYD.—Transferred to Grade of Associate Member, 412.
WEBB, HOWARD WILLIAM. — Elected an Associate Member, 461.
WEBSTER, GEORGE S.—Appointed Representative of Society on Engineering Division of National Research Council, 466, 492, 546.
WEBSTER, ROYAL SYLVESTER.—Transferred to Grade of Member, 462.
WEIL, CARL LESLIE.—Elected an Associate Member, 461.
WEIMER, KINZIE LA MAR. — Elected an Associate Member, 537.
WEINER, RUDOLPH SIGMUND.—Elected an Associate Member, 537.
WEIR, ROBERT JOHN.—Elected a Member, 868.
WEISKOPF, EDWARD FRANCIS. — Elected a Junior, 461.
WELLER, CURTIS D.—Elected an Associate Member, 881.
WELLER, FRANCIS R.—Appointed to Represent Society at Conference on Business Training for Engineers, etc., 546, 698.
WELLS, CLIFTON KENNADY, JR. — Elected a Junior, 538.
WENSTRAND, RALPH THEODORE. — Elected an Associate Member, 543.
WENTZ, FOSTER PRATT.—Elected an Associate Member, 119.
WERBIN, ISRAEL V.—Awarded the J. James R. Croes Medal, 116, 132.
WEST, FRANK HUBBLE.—Elected an Associate Member, 537.
WESTENHOFF, ALPHONSE MUELLER.—Transferred to Grade of Associate Member, 120.
Westinghouse Electric and Manufacturing Company.—Establishment by, Of Memorial Scholarships, 690.
WESTON, BENJAMIN THOMAS.—Transferred to Grade of Member, 544.
WETZLER, WILLIAM HENRY. — Elected a Member, 460.
WEYMOUTH, F. E.—On Nominating Committee, 116, 128, 133, 134.
WHALEN, WILLIAM EDWARD.—Transferred to Grade of Associate Member, 538.
WHIPPLE, GEORGE C.—Appointed Director of Division of Sanitation of League of Red Cross Societies, 939.
WHIPPLE, JOHN BLAINE.—Elected an Associate Member, 881.
WHITAKER, RALPH WARREN.—Elected an Associate Member, 881.
WHITE, BYRON ELLSWORTH. — Transferred to Grade of Member, 538.
WHITE, DAVID EWING. — Transferred to Grade of Associate Member, 412.
WHITE, JOHN ALOYSIUS.—Elected an Associate Member, 875.
WHITE, JOHN WESLEY. — Elected a Junior, 461; Death announced, 796.
WHITE, LAZARUS. — Discussion by, 795.
WHITMORE, HAROLD CUSHING. — Transferred to Grade of Associate Member, 412.
WHITNEY, CHARLES EARL. — Elected an Associate Member, 875.
WHITNEY, FREDERICK CLIFFORD. — Elected an Associate Member, 461.
WHITNEY, JAMES THEODORE.—Elected an Associate Member, 461.
WHITSON, MILTON JAMES.—Elected a Member, 873.
WHITTET, RUFUS MASON.—Death announced, 462.
WHITTIER, WILMOT EDGAR.—Elected a Member, 410.
WICKHAM, JAMES THOMAS.—Elected an Associate Member, 881.
WIERSEMA, HARRY ANTHONY.—Elected an Associate Member, 461.
WIG, RUDOLPH JAMES. — Invitation from, To Visit Yard of Fougner Shipbuilding Company, 121, 144; Transferred to Grade of Member, 871.
WILBANKS, JOHN ROBERT. — Transferred to Grade of Member, 876.
WILDER, HENRY LINCOLN.—Elected an Associate Member, 870.
WILGUS, W. J.—Discussion by, 878.
WILLCOMB, ROLAND HOWARD.—Elected an Associate Member, 119.

WILLEY

WILLEY, LEO CECIL.—Elected an Associate Member, 881.
WILLIAMS, F. P.—On Nominating Committee, 116, 128, 133, 134.
WILLIAMS, GARDNER S.—Discussion 541, 552.
WILLIAMS, GUY MORRIS.—Elected an Associate Member, 119.
WILLIAMS, JOHN HUW.—Elected a Member, 873.
WILLIAMS, RICHARD GILES.—Elected an Associate Member, 881.
WILLIAMS, TIMOTHY SILAS.—Elected an Associate Member, 543.
WILLIAMSON, LEE HOOMES.—Transferred to Grade of Associate Member, 877.
WILMOT, SIDNEY.—Transferred to Grade of Associate Member, 120.
WILSON, ELLIOTT HINCKLEY.—Death announced, 2.
WILSON, EMMET CHEATHAM.—Transferred to Grade of Associate Member, 538.
WILSON, EVERITT WYCHE.—Transferred to Grade of Member, 876.
WILSON, FRANCIS DOUGLAS.—Elected an Associate Member, 870.
WILSON, G. L.—On Local Committee of Arrangements for Annual Convention, 429, 495.
WILSON, HARRY KEITH.—Elected an Associate Member, 881.
WILSON, HUGH MONROE.—Death announced, 872.
WILSON, JAMES.—Death announced, 2.
WILSON, WILLIAM.—Transferred to Grade of Member, 120.
WILSON, WILLIAM HENRY.—Elected an Associate Member, 881.
WINCHELL, HORACE V.—Telegram from, 540, 550.
WINSHIP, LEF.—Elected an Associate Member, 543.
WISLER, CHESTER OWEN.—Elected an Associate Member, 461.
WITT, ROBERT EUBANK.—Elected an Associate Member, 881.
WITTE, HERMAN CALVERT.—Elected an Associate Member, 537.
WOLFE, WALTER MCILHANEY.—Elected an Associate Member, 881.
WOLFE, WILLIAM SIDNEY.—Elected an Associate Member, 537.

WOLFF

WOLFF, L. P.—On Local Committee of Arrangements for Annual Convention, 429, 495.
WONDERS, JAMES CREW.—Elected a Member, 460.
WONG, JICK GAM.—Transferred to Grade of Associate Member, 412.
WOOD, BENJAMIN RUSSELL.—Transferred to Grade of Member, 871.
WOOD, CARL WILBUR.—Elected an Associate Member, 870.
WOOD, CLYDE WARREN.—Elected an Associate Member, 543.
WOOD, EUGENE NORTH.—Elected an Associate Member, 875.
WOOD, IRVING SPARROW.—Death announced, 877.
WOODBURY, W. H.—Discussion by, 541, 559.
WOODWARD, FRANK COY.—Transferred to Grade of Member, 120.
WOODWARD, ROLAND.—Elected a Member, 410.
WOODWORTH, PAUL HENRY.—Elected an Associate Member, 461.
WOODY, NORMAN COOPER.—Transferred to Grade of Member, 120.
WOOLLEY, WILLIAM EDWARD.—Elected an Associate Member, 411.
WORCESTER, JOSEPH R.—Appointed as Representative of Society on Engineering Council, 125, 464.
"World War".—Designation Officially Announced, 965.
WRIGHT, CLARK CHITTENDEN.—Elected a Member, 536.
WRIGHT, FRANCIS H.—Discussion by, 872.
WRIGHT, THOMAS PARKS.—Elected an Associate Member, 411.
WYNN, ALBERT EDWARD.—Elected an Associate Member, 870.
WYNNE, HAROLD GEORGE.—Elected an Associate Member, 870.

YAGER, LOUIS.—Elected a Member, 868.
YATES, GEORGE STEVENSON.—Elected a Member, 536.
YATES, J. J.—On Nominating Committee, 116, 128, 133, 134.
Year Book, 1919.—Action by Board of Direction Relative to Recommendation to Reduce Cost of, 124.

YEAR

Year Book, 1920.—Report of Publication Committee to Board of Direction Relative to Changes in Style of, 463; Authorization by Board of Direction of Letter-Ballot on Changes in Style of, 463; Report of Secretary to Board of Direction, on Result of Ballot on Proposed Changes in, 540, 545, 550.

YORK, ROBERT EVERETT.—Elected a Junior, 881.

YOUNG

YOUNG, JOHN.—Elected an Associate Member, 543.

YOUNG, STELL KAY.—Elected an Associate Member, 881.

ZEE, NAI-ZUNG.—Elected a Junior, 876.

ZEHR, VRATISLAV ADOLPH. — Elected an Associate Member, 543.

ZIMMER, JUDSON.—Elected an Associate Member, 461.

PAPERS AND DISCUSSIONS

OCT.-NOV.-DEC., 1919

Vol. XLV. OCT.-NOV.-DEC., 1919. Nos. 8-9-10.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PAPERS AND DISCUSSIONS

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CONTENTS

Papers: PAGE

Experiments on the Flow of Water Through Contractions in an Open Channel.
By E. W. Lane, Assoc. M. Am. Soc. C. E. 715

The Production of Toluol from Gas Plants.
By Myron S. Falk, M. Am. Soc. C. E. 775

Discussions:

Verification of the Bazin Weir Formula by Hydro-Chemical Gaugings.
By Floyd A. Nagler, Assoc. M. Am. Soc. C. E. 795

Construction Methods Used in Building the Lower Reservoir Dam of the Balmorhea Project.
By Vernon L. Sullivan, M. Am. Soc. C. E. 809

On a New Principle in the Theory of Structures.
By H. T. Eddy, Esq. 811

Sewage and Wastes Disposal for the United States Army.
By A. L. Sherman, Assoc. M. Am. Soc. C. E. 817

American Highways: An Informal Discussion.
By William E. Woolley, Assoc. M. Am. Soc. C. E. 821

Water Supply for the Camps, Cantonments, and Other Projects Built by the Construction Division of the United States Army.
By Samuel A. Greeley, M. Am. Soc. C. E. 823

Contracts—A Comparison of "Cost Plus" with Other Forms.
By Messrs. F. Lavis, Missac Thompson, F. H. Frankland, J. Waldo Smith, Edward F. Hammel, Lazarus White, A. P. Davis, Henry H. Quimby, J. P. H. Perry, Henry B. Seaman, Frederick Glaeser, George D. Snyder, F. G. Baum, George Perrine, P. L. Reed, Walter H. Wheeler, E. G. Walker, and J. A. L. Waddell. 827

The Silt Problem of the Zuni Reservoir.
By Elwood Mead, M. Am. Soc. C. E. 889

Physiography of Water-Sheds and Channels, and Analysis of Stream Action of Southern California Rivers, with Reference to the Problems of Flood Control.
By Messrs. Charles A. Pohl, Francis H. Wright, and H. F. Dunham. 891

Is It Advisable to Establish a National Department of Public Works? An Informal Discussion.
By Messrs. George W. Fuller, Walter D. Blair, C. T. Chenery, A. B. Fry, Roger D. Black, Alfred D. Flinn, and H. F. Dunham. 901

Memoirs:

Charles Titus Church, M. Am. Soc. C. E. 935
John Vose Hazen, M. Am. Soc. C. E. 938
John Gibson Hendrie, M. Am. Soc. C. E. 940
George Stevens Leavenworth, M. Am. Soc. C. E. 941
Bruce Ritchie Honeyman, Assoc. M. Am. Soc. C. E. 942
William Menke, Assoc. M. Am. Soc. C. E. 943
Alexander Charles Schilling, Assoc. M. Am. Soc. C. E. 945
Robert Earle Shipley, Assoc. M. Am. Soc. C. E. 946
Hugo S. Speidel, Jun. Am. Soc. C. E. 948

PLATES

Plates XII–XIX. Illustrations of "Experiments on the Flow of Water Through Contractions in an Open Channel" ..... Pages 721 to 769

For Index to all Papers, the discussion of which is current in *Proceedings,* see the end of this number

Vol. XLV. OCT.-NOV.-DEC., 1919.* Nos. 8-9-10.

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INSTITUTED 1852

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EXPERIMENTS ON THE FLOW OF WATER THROUGH CONTRACTIONS IN AN OPEN CHANNEL†

By E. W. Lane, Assoc. M. Am. Soc. C. E.‡

Synopsis.

In the studies for the design of the flood prevention works of the Miami Conservancy District, the laws governing the flow of water through a contraction in an open channel assumed unusual importance. The available literature on the subject was uncertain and contradictory. To determinate the true laws governing the phenomena, the writer carried on, during the summers of 1915 and 1916, a series of small-scale experiments. Although conditions growing out of the war prevented their completion, some interesting results were obtained, and it is believed that they throw considerable light on this little understood subject. The experiments consisted of measurements of flow through:

(*a*) A contraction with rounded edges, 1 ft. wide.
(*b*) A sharp edge contraction, 1 ft. wide.
(*c*) A sharp edge contraction, 2 ft. wide.
(*d*) A short flume with rounded entrance.
(*e*) A short flume with sharp corner entrance.
(*f*) An expanding or Venturi flume.

In the following paper a description of the apparatus and the method of making the experiments is given, together with the results.

*Owing to the printers' strike, *Proceedings* were not issued for October and November. This number, therefore, covers the last three months of 1919.

† This paper will not be presented for discussion at any meeting of the Society, but written communications on the subject are invited for subsequent publication in *Proceedings*, and with the paper in *Transactions*.

‡ Dayton, Ohio.

Appendixes are attached containing:

I.—A brief description of the application of the theory of flow through contracted openings to the design of the flood prevention works of the Miami Conservancy District.

II.—A description of the unstable state of the stream below a sharp edge contraction.

Briefly stated, the most important conclusions drawn from these experiments are as follows:

The manner in which the flow of water through a contraction takes place, is entirely dependent on the conditions existing in that particular case. The two most common formulas are those of d'Aubuisson and Weisbach. Under certain conditions, one of these formulas may be applicable and, under another set of conditions, the other; while under still other conditions, neither should be used. The paper points out the various conditions of flow, the underlying causes, and the conditions under which they take place. The flow through a contraction is intimately connected with the phenomenon of "maximum flow", the theory of which is well known, but it is herein demonstrated experimentally, and its limitations are shown.

To explain the conditions of flow in the expanding flume, the theory of back-water curves was developed for a frictionless channel with a level bottom and variable width.

Certain forms of contractions were found to possess considerable merit as instruments for the measurement of flowing water.

The Theory of the Flow of Water Through a Contraction in an Open Channel.

The theory of the flow of water through a contraction in an open channel has been an unsettled problem in hydraulics for many years. At the time this investigation was undertaken, although available literature showed many discussions of the subject,* no record of experi-

* "Treatise on Hydraulics", by d'Aubuisson. Bennett's translation (New York, 1857), p. 189.
"Experimental Hydraulik", by Weisbach.
"On the Determination of the Flood Discharge of Rivers and of the Backwater Caused by Contractions", by W. R. Hutton, M. Am. Soc. C. E., *Transactions*, Am. Soc. C. E., Vol. XI (1882), p. 211.
"Treatise on Hydraulics", by Merriman. Eighth Edition, p. 327; Tenth Edition, p. 343a.
"Hydraulics of Rivers, Weirs, and Sluices", by Molitor, p. 32.
"Flow of Water", by Louis Schmeer, p. 180.
"Hydraulic Motors", by Church, p. 227.
"A Report to the Mayor and City Council on Flood Prevention for the City of Columbus, Ohio", by Alvord and Burdick, September, 1913, p. 80.
"The Official Plan of the Miami Conservancy District", Vol. I, pp. 67–71.

ments could be found, which was sufficiently complete to establish any of the theories proposed. Since this study was undertaken, a valuable history and discussion of the various theories has been presented to the Society,* and, therefore, only a brief discussion of the theory will be given in this paper.

Although a number of hydraulicians have proposed formulas to represent the relation of the various factors entering into this problem, they are all based on one or the other of two theories. For convenience, these theories will be given the names of the men who probably first proposed them, that is, the d'Aubuisson and the Weisbach theories.

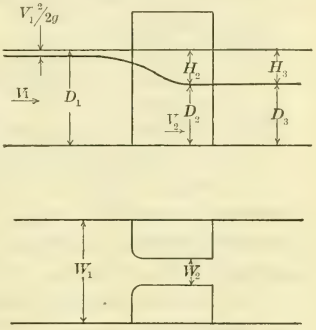


FIG. 1.

Symbols.—Fig. 1 represents the flow of water through a contraction, where:

V_1 = the mean velocity of the water above the contraction.

D_1 = the mean depth of the water above the contraction, including the velocity of the approach head. (The combining into one symbol of the observed depth above the contraction and the velocity of approach head, results in much simpler formulas, the meanings of which are more readily understood.)

W_1 = the mean width of the water above the contraction.

V_2 = the mean velocity of the water in the most contracted section of the channel.

D_2 = the mean depth of the water in the most contracted section of the channel.

W_2 = the mean width of the stream at the most contracted section of the channel.

H_2 = the drop of the water surface at the most contracted section, including the velocity of approach head.

* "Obstruction of Bridge Piers to the Flow of Water", by Floyd A. Nagler, Assoc. M. Am. Soc. C. E., *Transactions*, Am. Soc. C. E., Vol. LXXXII, p. 334 (1918).

g = the acceleration due to gravity.

$\frac{V_1^2}{2g}$ = the head due to the velocity of approach of the water above the contraction. This is usually included in D_1.

D_3 = the mean depth of the water in the channel below the contraction.

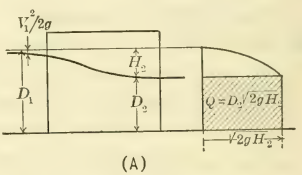
H_3 = the total drop of the water in passing through the contraction, or the observed drop plus the head due to the velocity of approach.

C = a coefficient to take account of losses due to friction, impact, etc. The subscripts, dA and W, designate the d'Aubuisson and the Weisbach coefficients, respectively.

Formulas.—According to the d'Aubuisson theory, V_2, the velocity in the contracted section, is equal to that produced by a drop, H_2, or V_2 is equal to $\sqrt{2\,g\,H_2}$, whence:

$$Q = C_{dA}\, W_2\, D_2\, V_2 = C_{dA}\, W_2\, D_2 \sqrt{2\,g\,H_2} \ldots\ldots\ldots (1)$$

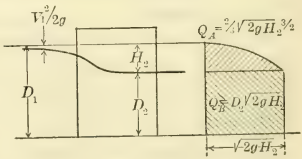
The d'Aubuisson formula is really only an application of the Bernouilli theorem. The discharge according to this formula is represented graphically, for a unit width of channel, by the cross-hatched portion of Fig. 2 (A).



(A)

Weisbach considered the flow as being made up of two parts: (a) a part equal to that which would flow over a weir with a crest length of W_2 and a head on the crest of H_2, or,

$$Q_A = C_A\, W_2\, \frac{2}{3} \sqrt{2\,g}\, H_2^{\frac{3}{2}} \ldots (2)$$



(B)

FIG. 2.

and (b), a part equal to that which would flow through an orifice of width, W_2, and height, D_2, under a head of H_2, or

$$Q_B = C_B\, W_2\, D_2 \sqrt{2\,g\,H_2} \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

These two portions are represented graphically, for a unit width, by

the two cross-hatched portions of Fig. 2 (*B*). In the formula, the two parts are combined with a single coefficient, giving:

$$Q_W = C_W W_2 \sqrt{2g} \left(\frac{2}{3} H_2^{\frac{3}{2}} + D_2 H_2^{\frac{1}{2}} \right) \ldots\ldots\ldots\ldots (4)$$

It will be noted that Part (*b*) of the discharge, according to the Weisbach theory, is exactly equal to the total discharge according to the d'Aubuisson theory. The Weisbach theory, therefore, always gives a theoretical discharge greater by the amount of the first part, $W_2^{\frac{3}{2}} \sqrt{2g}\, H_2^{\frac{3}{2}}$. In determining the value of the coefficient experimentally, where Q, W_2, D_2, and H_2, are measured, the coefficient, C_W, in the Weisbach formula, for a given experiment, will always be lower than the coefficient, C_{dA}, of the d'Aubuisson theory.

It is usually impractical to determine the depth, D_2, of the water in the most contracted section, on account of the difficulty of measuring the height of the water surface at this point. A common practice is to measure the water surface elevation below the contraction, and assume that the surface in the most contracted section is at the same elevation. For instance, in computing the height of back-water at a bridge opening, the usual practice is to assume that the water surface elevation in the most contracted section is the same as that in the river channel immediately below the bridge. In most cases of bridge openings, this is very nearly the true condition. In some cases, however, the assumption is far from the truth, and it has a very important effect on the nature of the coefficient which must be used to obtain the true values of discharge. In the computations of the three experimental contractions, this assumption was made, and its effect will be discussed in connection with the results of these experiments.

Description of Experimental Plant.

The experiments made by the writer to study the flow of water through contracted openings, were carried on in a rectangular channel, approximately 6.8 ft. wide and 2 ft. deep. The sides were formed by sheeting which had been used in connection with the laying of a water main, and the bottom was of gravel and silt. The channel paralleled the Mad River and received its water supply from it. The head necessary for the experiments was created by a fall of 2 ft. between the upper end of the channel and the point at which the water discharged back

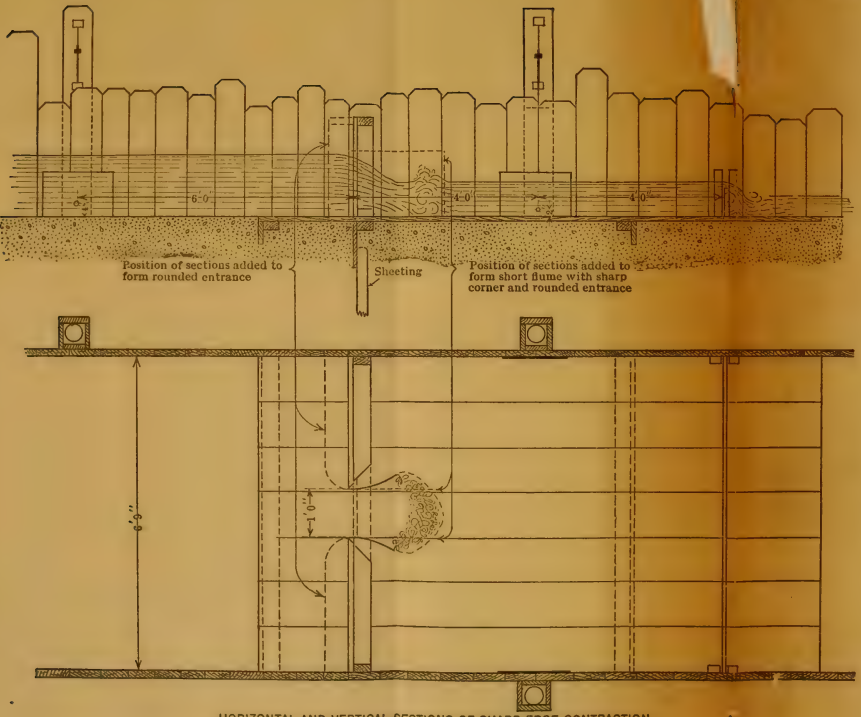
into the river. Of this drop, about 1½ ft. was available for experimental purposes.

The quantity of water used in the experiments was controlled by a by-pass in the side of the channel, about 40 ft. from its upper end. This consisted of a rectangular opening through which the excess flow was discharged back into the river, the quantity being regulated by small stop-logs. Forty feet below the regulator was the weir for measuring the discharge through the experimental contractions, which were built in the channel 86 ft. farther down stream.

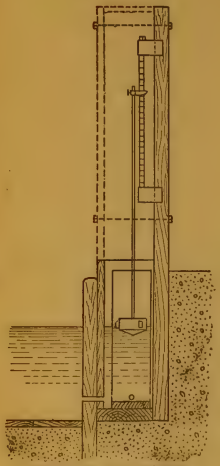
Measuring Weir and Float Gauges.—The measuring weir was of the Cippoletti type, with a crest length of 2 ft. The dimensions of its setting were made as nearly as possible like those of the weir on which experiments* were made by Messrs. W. G. Steward and J. S. Longwell, Jun. Am. Soc. C. E., in order that the coefficients derived by them might be used in computing the discharge. The weir bulkhead was of wood, while the crest was formed of heavy galvanized iron, cut to a straight, smooth edge. The weir was in place several months, and the swelling of the wood and consequent change of crest elevation was complete, before any discharge measurements were made. As in the setting used by Messrs. Steward and Longwell, the crest of the weir was 1 ft. above the bottom of the channel of approach, and the head was measured at a point 10 ft. up stream from the bulkhead.

Float gauges of unusual design were used to measure the head. (Plate XII.) They were set in a wooden pit, 6 by 6¾ in., set outside the channel and connected to it through the sheeting by a piece of ⅜-in. pipe, 3 in. long, ending flush with the side of the channel. In order that no cross-currents might be created near the end of the pipe by the irregularities of the sheeting, a piece of galvanized iron was placed over the side of the channel at this point, with a hole drilled through it where it covered the end of the pipe. Inside, and resting on the bottom of, the pit was a cylindrical tube of galvanized iron, 5 in. in diameter, open at the top. In the sides of this cylinder, 1 in. above the bottom, were four holes, ⅜ in. in diameter, spaced equally around the circumference. This tube served as a guide for the float, which was cylindrical in shape, 4 in. in diameter and 2 in. high, with a conical bottom, to prevent air being entrapped beneath it thus alter-

* *Transactions*, Am. Soc. C. E., Vol. LXXVI, p. 1045.



HORIZONTAL AND VERTICAL SECTIONS OF SHARP EDGE CONTRACTION



SECTION OF FLOAT GAUGE.

ing its buoyancy. On the sides of the float were three fins, ½ in. wide, extending out radially to prevent it from rubbing on the side of the tube. Connected to the float by a small brass rod, was a pointer which moved over a steel tape graduated to hundredths of a foot, the tape serving the double purpose of a scale for reading the position of the float and as a guide for the pointer. The gauges were fitted with a wooden box-like cover which was bolted and locked on them when not in use to prevent their being tampered with. When the experiments were undertaken, it was proposed to place the cylinder and float directly in the channel. This was found to be impracticable, on account of cross-currents, and they were enclosed, therefore, in boxes and placed outside the channel, connected to it with pipes as described.

Float gauges of a somewhat similar pattern, in which the float moves in a cylinder which is connected at the bottom directly to the side of the channel, have been used for several years in the Hydraulic Laboratory of Cornell University, and have been found to be very satisfactory devices for measuring head, particularly if there is considerable wave action. The float gauge has several advantages over the hook gauge for reading water levels. Readings may be taken more rapidly with it; and instantaneous readings, maximum and minimum, and the character of surges can be readily observed. The writer believes that the accuracy obtainable under ordinary conditions is equal, and, in disturbed water, exceeds that which it is possible to obtain with a hook gauge.

Contractions.—A section of the sharp edge contraction is shown on Plate XII, and Fig. 3 shows the flow of water through it. The contraction consisted of two vertical walls, ending with sharp vertical edges formed of galvanized iron, extending out at right angles from the sides of a rectangular channel. The bottom of the channel at this point was formed of planed boards, with cut-off walls below to prevent seepage under the contraction. The height of the water surface above the contraction was measured by one float gauge, 6 ft. above the most contracted section, and the down-stream by two gauges, one on each side of the flume, 4 ft. below this point. The height of the water surface below the contraction was controlled by a series of small stop-logs, 4 ft. below the down-stream gauges. It was first planned to place this regulator at a considerable distance below the contraction, but when so placed an unstable condition of the jet resulted, which neces-

sitated placing the stop-logs near the contraction. This condition of the jet is described in full in Appendix II. The curved contraction was formed by placing attachments of galvanized iron, curved to a radius of 0.5 ft. above the sharp edge contraction, as shown on Plate XII and Fig. 4.

Short Flumes.—The short flume with sharp corner entrance was formed by placing two galvanized iron sheets, 2 ft. long, below the sharp edge contraction, as shown on Plate XII. These sheets were fastened securely to the bottom of the channel and braced at the top to hold them in position. The short flume with rounded entrance was formed by placing these pieces below the contraction with rounded entrance.

Expanding Flume.—Plate XVIII shows the cross-section of the expanding or Venturi flume. This flume had sheet-iron sides, tacked to a wooden form which was cut accurately to the desired shape. The entrance was formed by curves of 0.5 ft. radius. Below these, the sides were parallel, 1.0 ft. apart, for 2.0 ft., at which point they began to diverge along the parabolic curve, $y = 0.0178\ x^2$, reaching a distance of 3.0 ft. apart at the lower end of the flume, the total length being 10.0 ft. The flume was set in the channel and connected at the upper end with the same bulkhead that was used for the sharp edge contraction. The bottom of the flume was not exactly level, the down-stream end being slightly higher than the up-stream end. Practically all the slope was in the expanding section of the flume and probably had little, if any, effect on the results.

Point Gauge.—For the determination of the elevation of the water surface in the short and expanding flumes, a point gauge was used. The rod was graduated to hundredths of a foot and moved vertically past a vernier, from which the thousandths of a foot could be read. The rod and vernier were conveyed on a carriage which moved across the channel on a beam, at the ends of which were bearing plates clamped to the framing of the sides of the flume. The position occupied by the bearing plates at each measuring section was marked on the framing of the flume, in order that the beam could be placed in exactly the same position for each reading at that section.

Experimental Methods.

Weir and Float Gauges.—Two methods of determining the gauge zero of the weir were used. In the first of these, readings were taken

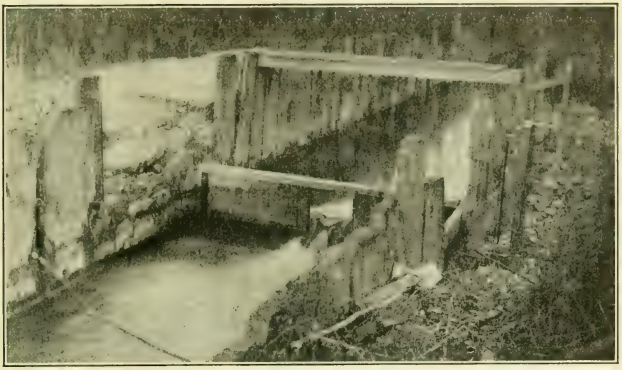


Fig. 3.—One-Foot Sharp Edge Contraction, Showing Float Gauges.

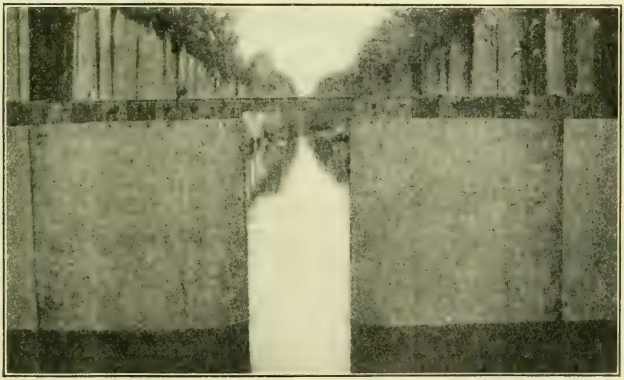


Fig. 4.—Contraction with Rounded Edges, Up-Stream Side.

with an engineer's level and rod at several points on the crest of the weir, and on the point of a stationary hook which was fastened to the side of the channel near the float gauge. This hook had a sharp point like an ordinary hook gauge, but was constructed of much heavier material, in order to carry the weight of the level rod without deflection. The lower end of the channel was closed, and water was admitted very slowly until the surface rose slightly above the point of the hook. At the instant the surface reached the point of the hook, a reading of the float gauge was taken. Water was then discharged slowly until the surface again fell below the point, another reading of the float gauge being taken at the instant the water surface reached the point of the stationary hook. The mean of several such observations, which never varied more than a few thousandths of a foot, was taken as the reading of the float gauge corresponding to the elevation of the point of the hook. Knowing the difference in elevation between the crest of the weir and the point of the hook, as determined by level-rod readings, the reading of the float gauge corresponding to the elevation of the weir crest could be readily determined.

In the second method, by the point gauge, water was ponded in the experimental channel to a sufficient depth to cover the weir crest. The difference in elevation between the crest of the weir and the water surface in the channel was measured with the point gauge at several points along the weir crest, readings of the float gauge being noted at the same time. From these, the float-gauge readings corresponding to the elevation of the weir crest were determined. Both these methods were also used in determining the gauge reading equivalent to the bottom of the contractions.

Contractions.—For the experiments on the contractions with sharp edges, and on the contraction with the rounded entrance, the procedure was the same. Each run consisted of five observations of head on the measuring weir, five on the gauge above the contraction, and ten on each of the gauges below the contraction. The readings on the weir and up-stream gauge varied little during a run, but as a result of the turbulent water below the contraction, considerable fluctuation occurred in the down-stream gauge readings, and, therefore, more observations were required to arrive at an accurate mean. The time required for a run was about 30 min.

Short and Expanding Flumes.—The width of the short and expanding flumes was measured at several elevations at each observation section, by large inside calipers. From these measurements a table was prepared, showing the area of the cross-section of the flume at each observation section for the various depths. To refer the observations on the water surface with the point gauge, the readings of the float gauges, and the elevation of the bottom of the flume at each station, to a common datum, the procedure was as follows: Water was ponded in the flume, the beam of the point gauge was clamped in the proper position, and readings were taken on the water surface and bottom of the flume, at each measuring station, at the same points in the cross-section, which were used later in the flow observations. Simultaneous observations of the water surface elevation, as recorded by the float gauges, were also made. The difference, at any measuring station, between the mean of the readings on the water surface and the mean of those on the bottom, gave the mean depth of water at that section. Knowing the float-gauge readings, as observed for this water surface elevation, the gauge reading corresponding to the bottom of the flume was readily computed. In like manner, the reading of the float gauge equivalent to the mean height of the point-gauge beam was determined for each measuring station.

A run consisted of observations of discharge, depth above and below the contraction, and water surface elevation at the various observing stations. Readings of the weir gauge and the gauges above and below the flumes, for determining the values of the discharge, Q, and of the depths, D_1 and D_3, were made after the measurement of the elevation of the water surface at each station. These stations were spaced along the flume at such distances apart that the profile of the mean water surface could be determined accurately. This was approximately 0.25 ft. in the narrow section of the flumes, but farther apart in the wider portions. At each measuring section in the narrower portions, readings of the water surface elevation were taken at each side and at every 0.2-ft. point between, although, in some cases, they were taken every 0.1 ft. In the lower $2\frac{1}{2}$ ft. of the expanding flume, readings were usually taken 0.3 ft. apart.

Computations.

In the computations for these experiments, all distances were taken to the nearest thousandth of a foot, discharge to the nearest thousandth

of a cubic foot per second, and the coefficients were computed to three decimal places. The multiplications were performed with a Thatcher slide-rule or a five-place logarithmic table.

Weir.—The discharge over the weir was computed by the formula:

$$Q = C\,L\left(H + \frac{V^2}{2\,g}\right)^{\frac{3}{2}} \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

The values of C were taken from a curve showing the relation of the head to the value of the coefficient, as obtained from the experiments of Messrs. Steward and Longwell previously referred to, on a 2-ft. Cippoletti weir. The length of the crest, L, was obtained by accurate measurements, and H was determined by subtracting the gauge reading corresponding to the weir crest elevation from the reading of the water surface above the weir, corrected for velocity of approach. On all experiments except those on the expanding flume, the mean of the weir gauge readings was used in computing the discharge. For the expanding flume experiments, the discharge corresponding to each gauge reading was computed. The values of the velocity of the approach head, $\frac{V_1^2}{2\,g}$, were read from a curve computed to show its magnitude for the various values of H.

Contractions.—For the contractions, the equation for the computation of the coefficients in the d'Aubuisson formula was:

$$C_{d.1} = \frac{Q}{W_2\,D_2\sqrt{2\,g\,(D_1 - D_2)}}. \ldots\ldots\ldots\ldots\ldots (6)$$

The quantity, D_1, the total depth above the contraction, was determined from the mean of the up-stream gauge readings, by subtracting from this mean the reading of the gauge corresponding to the elevation of the bottom of the contraction. To this was added the velocity of approach, $\frac{V_1^2}{2\,g}$, V_1 being computed by dividing the measured discharge by the area of the approach channel at the depth, D_1. The value of the width of the contraction, W_2, was determined by measurement with a scale or caliper. The depth at the most contracted section, D_2, was not measured, but, as has been previously noted, the values of D_3, the depth below the contraction, which were determined from the readings of the down-stream gauges, were used in place of D_2, in computing the coefficients by the various formulas.

The computation of the coefficient by the Weisbach formula:

$$C_w = \frac{Q}{W_2 \sqrt{2g}\left(\frac{2}{3} H_2^{\frac{3}{2}} + D_2 H_2^{\frac{1}{2}}\right)} \quad \ldots\ldots\ldots\ldots (7)$$

was made in a manner similar to that for the d'Aubuisson formula. As the bottom was level, $H_3 = D_1 - D_3$, the measured values of H_3 and D_3 being used in the computations, in place of H_2 and D_2, respectively.

Short Flumes.—The computations of the results of the experiments on the short flumes were made in a manner similar to those for the contractions. The same formulas were used, but the coefficients were worked out for each measuring station along the length of the flume, the value of D_2 being the mean depth, and that of W_2 the mean width, as measured for that station. The discharge throughout the run was practically constant, and the mean discharge, therefore, was used for Q. As the bottom was level, $H_2 = D_1 - D_2$. In computing the coefficients for the points below the end of the short flume, the width, W_2, was assumed to be the same as that of the flume at its lower end. It will be noticed that this is the same, in effect, as the assumption usually made in computing the discharge at bridge openings, and, under certain conditions, may lead to erroneous results, as shown on page 752.

Expanding Flume.—In the experiments on the expanding flume, the coefficients were worked out for each observation section. During a run, a slight change of discharge took place and, therefore, the discharge at the time the measurement was made at any station was used in the computations for that station. The formulas used for the contractions had to be modified somewhat for the expanding flume, as the bottom was not exactly level and $D_1 - D_2$ was not equal to H_2. The true drop was determined by subtracting the elevation of the water surface in the flume, as determined by the point gauge, from the elevation of the water surface above the contraction, as determined by the float gauge, the latter elevation being corrected for the velocity of approach. The measured depth and width at each station were used for D_2 and W_2, respectively.

Results of Experiments on Contractions.

The results of these experiments are given in numerical form in Tables 1 to 10, inclusive. They are also shown graphically on many

TABLE 1.—Results of Experiments on Contraction with Rounded Edges, 1 Ft. Wide.

Run No.	Depth below.	Drop.	Width.	Discharge.	Coefficients:	
					d'Aubuisson.	Weisbach.
1	1.094	0.115	1.002	2.525	0.846	0.791
2	1.042	0.130	1.002	2.659	0.880	0.813
3	0.953	0.172	1.002	2.780	0.875	0.781
4	0.889	0.199	1.002	2.796	0.877	0.763
5	0.838	0.205	1.002	2.682	0.879	0.756
6	1.010	0.127	1.002	2.556	0.883	0.815
7	0.998	0.255	1.002	3.661	0.903	0.772
8	1.132	0.212	1.002	3.704	0.884	0.786
9	1.094	0.220	1.002	3.695	0.895	0.789
10	0.940	0.287	1.002	3.687	0.910	0.757
11	0.876	0.318	1.002	3.662	0.922	0.742
12	0.799	0.453	1.002	4.238	0.980	0.711
13	0.668	0.588	1.001	4.193	1.065	0.693
14	0.733	0.484	1.002	4.148	1.012	0.702
15	0.758	0.570	1.002	4.941	1.074	0.715
16	0.811	0.530	1.002	4.894	1.031	0.718
17	0.889	0.458	1.002	4.752	0.982	0.731
18	0.952	0.393	1.002	4.547	0.948	0.743
19	1.050	0.331	1.002	4.464	0.919	0.759
20	1.118	0.300	1.002	4.464	0 907	0.769
21	0.666	0.496	1.001	3.911	1.038	0.694
22	0.713	0.460	1.002	3.858	0.992	0.694
23	0.786	0.397	1.002	3.773	0.948	0.709
24	0.581	0.188	1.001	1.855	0.917	0.754
25	0.739	0.120	1.002	1.842	0,895	0.808
26	0.636	0.160	1.002	1.822	0.891	0.763
27	0.618	0.319	1.001	2.682	0.957	0.712
28	0.706	0.258	1.002	2.637	0.915	0.735
29	0.656	0.283	1.001	2.606	0.930	0.722
30	0.764	0.217	1.002	2.592	0.906	0.762
31	0.817	0.191	1.002	2.585	0.900	0.779
32	0.574	0.186	1.001	1.802	0.906	0.745

of the diagrams. The consistency of the results is highly satisfactory, considering the conditions. In these experiments, it was necessary to measure the difference in elevation between two water surfaces, one of which was subject to considerable fluctuation. In addition, this difference of water level was small, averaging not more than 0.4 ft. A slight error in the observation of either of the water levels, therefore, would result in a considerable error in the coefficient.

Contraction with Rounded Edges.—The results of the experiments on the contraction with rounded edges, on the basis of the d'Aubuisson and the Weisbach formulas, are given in Table 1, and are shown graphically on Figs. 5 and 6. Each run is plotted, its position showing the relation of D_1, the depth above the contraction, to D_3, the depth below. At each of these points is recorded the values of the coefficient obtained for that run. Lines of equal drop (H_3), are drawn for each 0.1 ft., as well as lines of equal values of the ratio, $\frac{H_3}{D_3}$, for each 0.1.

TABLE 2.—Results of Experiments on Sharp Edge Contraction, 1 Ft. Wide.

Run No.	Depth below.	Drop.	Width.	Discharge.	Coefficients:	
					d'Aubuisson.	Weisbach.
1	0.675	0.354	1.000	2.456	0.762	0.565
2	0.598	0.250	1.000	1.747	0.728	0.570
3	0.634	0.339	1.000	2.274	0.768	0.566
4	0.664	0.456	1.000	2.962	0.824	0.564
5	0.655	0.437	1.000	2.815	0.811	0.561
6	0.715	0.590	1.000	3.870	0.878	0.567
7	0.678	0.479	1.000	3.122	0.829	0.563
8	0.742	0.616	1.000	4.080	0.874	0.562
9	0.720	0.573	1.000	3.768	0.861	0.563
10	0.686	0.507	1.000	3.290	0.840	0.562
11	0.659	0.542	1.000	3.499	0.848	0.559
12	0.716	0.579	1.000	3.765	0.862	0.560
13	0.650	0.311	1.000	2.137	0.784	0.557
14	0.638	0.281	1.000	1.973	0.725	0.562
15	0.668	0.392	1.000	2.610	0.778	0.559
16	0.780	0.320	1.000	2.602	0.724	0.565
17	0.814	0.418	1.000	3.218	0.762	0.568
18	0.820	0.436	1.000	3.324	0.765	0.565
19	0.825	0.449	1.000	3.431	0.774	0.568
20	0.850	0.524	1.000	3.940	0.798	0.566
21	0.746	0.185	1.000	1.716	0.667	0.572
22	0.770	0.308	1.000	2.433	0.716	0.567
23	0.789	0.355	1.000	2.778	0.736	0.567
24	0.738	0.159	1.000	1.558	0.660	0.577
25	0.760	0.251	1.000	2.122	0.695	0.569
26	0.752	0.210	1.000	1.886	0.682	0.575
27	0.851	0.501	0.996	3.809	0.791	0.568
28	0.958	0.442	0.996	3.818	0.750	0.574
29	0.952	0.417	0.996	3.640	0.742	0.574
30	0.842	0.476	0.996	3.649	0.787	0.571
31	0.932	0.382	0.996	3.380	0.735	0.577
32	0.923	0.362	0.996	3.218	0.725	0.575
33	0.970	0.444	0.996	3.880	0.752	0.576
34	0.928	0.323	0.096	2.977	0.706	0.574
35	0.920	0.296	0.996	2.792	0.698	0.574
36	0.917	0.269	0.995	2.618	0.690	0.577
37	0.940	0.336	0.995	3.114	0.716	0.578
38	0.856	0.185	0.994	1.906	0.649	0.567
39	0.906	0.248	0.994	2.449	0.680	0.575
40	0.885	0.217	0.994	2.219	0.675	0.580
41	0.899	0.184	0.993	2.020	0.657	0.579
42	0.776	0.388	0.993	2.924	0.760	0.570
43	0.592	0.215	0.993	1.558	0.712	0.574
44	0.900	0.152	0.993	1.821	0.652	0.585

It will be noticed that the coefficients for this contraction, according to the Weisbach formula, vary from 0.693 to 0.815, while those of the d'Aubuisson formula vary from 0.846 to 1.074. It would seem that neither formula is a rational expression for the true condition of flow, since with the rounded edges there would be no contraction of the jet, and from the coefficient for orifices with rounded edges, one would expect that the coefficient in the true formula for this contraction would be nearly unity. The d'Aubuisson coefficients fit this condition more closely than those of the Weisbach formula. Some of the d'Aubuisson coefficients, however, have values greater than unity,

TABLE 3.—Results of Experiments on Sharp Edge Contraction, 2 Ft. Wide.

Run No.	Depth below.	Drop.	Width.	Discharge.	Coefficients: d'Aubuisson.	Coefficients: Weisbach.
1	1.018	0.248	2.000	5.780	0.710	0.611
2	0.816	0.341	2.000	5.830	0.762	0.596
3	0.912	0.295	2.000	5.820	0.732	0.602
4	0.959	0.274	2.000	5.771	0.716	0.602
5	0.862	0.314	2.000	5.729	0.739	0.595
6	0.784	0.306	2.000	5.231	0.752	0.596
7	1.084	0.177	2.000	4.981	0.680	0.614
8	0.718	0.321	2.000	4.990	0.764	0.589
9	1.026	0.145	2.000	4.130	0.659	0.602
10	0.700	0.256	2.000	4.130	0.726	0.584
11	0.787	0.220	2.000	4.120	0.695	0.586
12	0.881	0.184	2.000	4.130	0.681	0.598
13	0.977	0.153	2.000	4.120	0.672	0.608
14	0.908	0.120	2.000	3.303	0.654	0.601
15	0.672	0.190	2.000	3.336	0.710	0.597
16	1.026	0.184	2.000	4.752	0.673	0.600
17	0.968	0.201	2.000	4.752	0.682	0.599
18	0.894	0.225	2.000	4.743	0.697	0.597
19	0.882	0.252	2.000	4.733	0.706	0.588
20	0.786	0.278	2.000	4.743	0.720	0.584
21	0.853	0.115	1.997	3.030	0.654	0.600

TABLE 4.—Results of Experiments on Short Flume with Rounded Entrance.

Position.	Width.	Area.	Drop.	Discharge.	Coefficients: d'Aubuisson.	Coefficients: Weisbach.
Run No. 1:						
0.50	0.975	1.106	0.182	4.267	1.126	1.020
1.00	1.000	0.926	0.390	4.267	0.919	0.718
1.50	1.000	0.843	0.469	4.267	0.921	0.672
1.75	1.000	0.818	0.497	4.267	0.922	0.656
2.00	0.995	0.814	0.501	4.267	0.922	0.653
2.17	0.990	0.826	0.486	4.267	0.924	0.662
2.67	*0.990	0.862	0.441	4.267	0.929	0.691
Pool	*0.990	0.849	0.453	4.267	0.930	0.684
Run No. 2:						
0.50	0.975	1.167	0.212	4.735	1.098	0.982
1.00	1.000	0.997	0.405	4.735	0.930	0.696
1.50	1.000	0.913	0.493	4.735	0.921	0.677
1.75	1.000	0.876	0.532	4.735	0.923	0.657
2.00	0.995	0.868	0.540	4.735	0.924	0.653
2.17	0.990	0.866	0.538	4.735	0.928	0.655
2.67	*0.990	0.883	0.512	4.735	0.934	0.672
Pool	*0.990	0.787	0.508	4.735	1.052	0.733
Run No. 3:						
0.50	0.975	0.954	0.187	3.537	1.068	0.947
1.00	1.000	0.812	0.356	3.537	0.910	0.704
1.50	1.000	0.734	0.427	3.537	0.918	0.662
1.75	1.000	0.724	0.440	3.537	0.918	0.653
2.17	0.990	0.740	0.420	3.537	0.919	0.665
2.67	*0.990	0.806	0.345	3.537	0.931	0.722
Pool	*0.990	0.790	0.362	3.537	0.967	0.709

* Assumed to be the same as the lower end of the flume.

TABLE 5.—Results of Experiments on Short Flume, with Sharp Corner Entrance.

Station.	Width	Area.	Drop.	Discharge.	Coefficients:	
					d'Aubuisson.	Weisbach.
Run No. 1:						
0.50	1.000	0.787	0.378	3.185	0.823	0.621
1.00	1.000	0.626	0.537	3.185	0.865	0.550
1.25	1.000	0.588	0.578	3.185	0.888	0.536
1.50	0.995	0.590	0.574	3.185	0.888	0.538
1.67	0.990	0.598	0.559	3.185	0.888	0.545
2.17	*0.990	0.733	0.421	3.185	0.815	0.602
Pool	*0.990	0.731	0.424	3.185	0.834	0.600
Run No. 2:						
0.50	1.000	0.587	0.333	2.212	0.816	0.590
1.00	1.000	0.475	0.444	2.212	0.871	0.536
1.25	1.000	0.476	0.446	2.212	0.868	0.534
1.67	0.990	0.586	0.326	2.212	0.824	0.599
2.17	*0.990	0.705	0.206	2.212	0.862	0.720
Pool	*0.990	0.655	0.256	2.212	0.832	0.658

* Assumed to be the same as the lower end of the flume.

TABLE 6.—Results of Experiments on Expanding Flume, Run No. 1.

Station.	Bottom Elevation.*	Width.	Area.	Drop.	Discharge.	Coefficients:	
						d'Aubuisson.	Weisbach.
0.50	0.007	0.996	0.882	0.163	2.967	1.038	0.926
0.75	0.000	0.987	0.792	0.255	2.974	0.927	0.765
1.00	0.001	0.984	0.720	0.323	2.967	0.904	0.698
1.25	0.001	0.988	0.684	0.362	2.959	0.896	0.664
1.50	0.008	0.987	0.639	0.400	2.959	0.912	0.646
1.75	0.008	0.992	0.626	0.416	2.959	0.913	0.635
2.00	0.006	0.988	0.616	0.426	2.974	0.922	0.634
2.25	0.010	0.985	0.603	0.436	2.990	0.936	0.634
2.50	0.009	0.979	0.596	0.442	2.995	0.942	0.633
3.00	0.015	0.991	0.590	0.452	3.000	0.942	.....
3.50	0.008	.....	.....	.....	.....	.....	.....
4.00	0.015	1.055	0.569	0.509	3.006	0.923	.....
4.50	0.021	.....	.....	.....	.....	.....	.....
5.00	0.022	.....	.....	.....	.....	.....	.....
5.50	0.024	1.306	0.532	0.633	3.010	0.886	.....
6.00	0.027						
6.50	0.023			6.00 to 7.00 Jump.			
7.00	0.048						
7.50	0.045						
8.00	0.057	2.095	1.320	0.378	3.014	0.463	.....
8.50	0.044	.....	.....	.....	.....	.....	.....
9.00	0.061	2.430	1.567	0.359	3.018	0.401	.....
10.00	0.085	.....	.....	.....	.....	.....	.....

* Above the lowest point of the bottom.

TABLE 7.—Results of Experiments on Expanding Flume, Run No. 2.

Station.	Width.	Area.	Drop.	Discharge.	Coefficients:	
					d'Aubuisson.	Weisbach.
0.50	0.996	0.898	0.169	3.077	1.039	0.924
0.75	0.986	0.814	0.253	3.093	0.941	0.782
1.00	0.984	0.750	0.316	3.101	0.916	0.718
1.25	0.988	0.705	0.365	3.109	0.910	0.678
1.50	0.987	0.670	0.396	3.115	0.921	0.663
1.75	0.992	0.651	0.422	3.121	0.920	0.645
2.00	0.988	0.632	0.442	3.126	0.927	0.635
2.25	0.985	0.621	0.448	3.126	0.937	0.635
2.50	0.980	0.624	0.442	3.126	0.939	0.640
3.00	0.991	0.617	0.450	3.126	0.941	.....
3.50	1.017	0.630	0.462	3.126	0.910	.....
4.00	1.055	0.665	0.443	3.123	0.879	.....
4.50 to 5.50 Jump						
6.00	1.419	1.175	0.232	3.120	0.687	.....
7.00	1.702	1.477	0.169	3.117	0.640	.....
8.50	2.300	2.001	0.172	3.117	0.468	.....
10.00	2.990	2.521	0.159	3.117	0.386	.....

TABLE 8.—Results of Experiments on Expanding Flume, Run No. 3.

Station.	Width.	Area.	Drop.	Discharge.	Coefficients:	
					d'Aubuisson.	Weisbach.
0.50	0.996	0.932	0.166	3.166	1.040	0.930
0.75	0.987	0.855	0.246	3.178	0.934	0.785
1.00	0.984	0.793	0.308	3.190	0.903	0.719
1.25	0.988	0.759	0.348	3.194	0.889	0.683
1.50	0.987	0.728	0.374	3.198	0.895	0.669
1.75	0.992	0.718	0.389	3.202	0.891	0.657
2.00	0.988	0.723	0.386	3.206	0.889	0.658
2.25	0.986	0.741	0.362	3.210	0.897	0.679
2.50	0.982	0.806	0.295	3.214	0.915	0.737
3.00	0.995	0.873	0.231	3.206	0.952	.....
3.50	1.023	0.917	0.216	3.198	0.935	.....
4.00	1.055	0.872	0.279	3.190	0.863	.....
4.50	1.121	0.907	0.288	3.179	0.814	.....
5.00	1.210	1.140	0.152	3.168	0.888	.....
5.50	1.309	1.219	0.160	3.158	0.807	.....
6.00	1.420	1.277	0.188	3.158	0.711	.....
7.50	1.894	1.703	0.168	3.158	0.564	.....
10.00	2.990	2.709	0.119	3.158	0.421	.....

which, as there must be some loss due to friction, would seem to prove that this formula is irrational. A closer study, however, in connection with the conditions of flow existing in those runs which gave coefficients greater than unity, shows that because of the assumptions made in computing the coefficients, these results would be expected.

TABLE 9.—Results of Experiments on Expanding Flume, Run No. 4.

Station.	Width.	Area.	Drop.	Discharge.	Coefficients:	
					d'Aubuisson.	Weisbach.
0.50	0.996	1.026	0.144	3.150	1.008	0.923
0.75	0.986	0.958	0.211	3.154	0.893	0.780
1.00	0.985	0 924	0.247	3.158	0.857	0.729
1.25	0.988	0.917	0.258	3.174	0.849	0.716
1.50	0.988	0.932	0.238	3.190	0.874	0.748
1.75	0.991	0.969	0.202	3.198	0.915	0.805
2.00	0.989	1.060	0.109	3.206	1.141	1.069
2.25	0.986	1.069	0.102	3.214	1.173	1.104
2.50	0.984	1.009	0.170	3.232	0.965	0.869
3.00	0.996	0.945	0.241	3.218	0.864	.....
3.50	1.026	0.972	0.251	3.214	0.822	.....
4.00	1.055	1.146	0.105	3.214	1.078	.....
4.50	1.121	1.144	0.163	3.214	0.867	.....
5.00	1.210	1.188	0.198	3.202	0.755	.....
6.00	1.420	1.498	0.117	3.190	0.776	.....
7.50	1.894	1.989	0.103	3.190	0.623	.....
10.00	2.990	3.050	0.093	3.190	0.427	.....

TABLE 10.—Results of Experiments on Expanding Flume, Run No. 5.

Station	Width.	Area.	Drop.	Discharge.	Coefficients:	
					d'Aubuisson.	Weisbach.
0.50	0.997	1.204	0.118	3.150	0.949	0.892
0.75	0.985	1.156	0.158	3.142	0.852	0.782
1.00	0.986	1.157	0.157	3.134	0.852	0.782
1.50	0.987	1.206	0.094	3.118	1.051	1.000
2.00	0.989	1.159	0.138	3.101	0.898	0.832
2.50	0.985	1.151	0.135	3.083	0.908	0.843
3.50	1.028	1.181	0.146	3.065	0.846	.....
5.00	1.211	1.418	0.100	3.046	0.816	.....
7.00	1.704	1.992	0.069	3.022	0.720	.....
10.00	2.990	3.361	0.067	2.990	0.428	.....

Instead of proving the irrationality of the d'Aubuisson formula, they really tend to substantiate it.

Consider the d'Aubuisson formula:

$$Q = C_{dA}\, W_2\, D_2 \sqrt{2\, g\, H_2}$$

$$= C_{dA}\, W_2\, D_2 \sqrt{2\, g\, (D_1 - D_2)} \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Differentiating with respect to D_2 and equating dQ to zero, in order

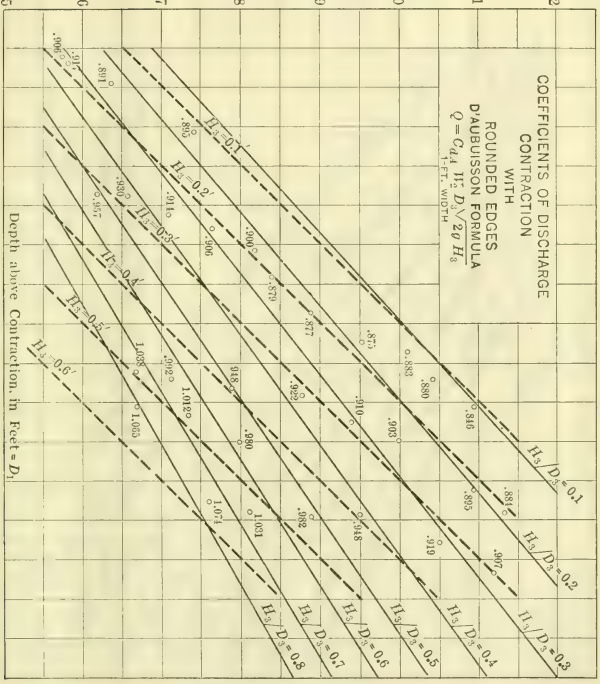

COEFFICIENTS OF DISCHARGE
CONTRACTION
WITH
ROUNDED EDGES
D'AUBUISSON FORMULA
$Q = C_{d_4} H_1 D_1 \sqrt{2g H_3}$
$C_{d_4} = .602 + .075 \frac{H_3}{D_3}$
Depth below Contraction, in Feet = D_3
Depth above Contraction, in Feet = D_1
$H_3/D_3 = 0.1$
$H_3/D_3 = 0.2$
$H_3/D_3 = 0.3$
$H_3/D_3 = 0.4$
$H_3/D_3 = 0.5$
$H_3/D_3 = 0.6$
$H_3/D_3 = 0.7$
$H_3/D_3 = 0.8$
$H_1/D_1 = 0.1$
$H_1/D_1 = 0.2$
$H_1/D_1 = 0.3$
$H_1/D_1 = 0.4$
$H_1/D_1 = 0.5$
$H_1/D_1 = 0.6$
$H_1/D_1 = 0.7$

Fig. 5.

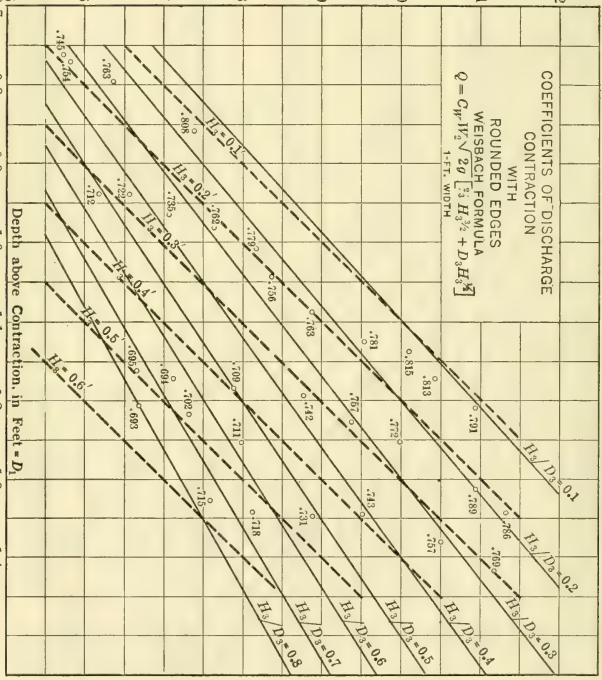

COEFFICIENTS OF DISCHARGE
CONTRACTION
WITH
ROUNDED EDGES
WEISBACH FORMULA
$Q = C_W l V_2 \sqrt{2g} \left[\frac{2}{3} H_2^{3/2} + D_3 H_2^{1/2}\right]$
1-FT. WIDTH
Depth below Contraction, in Feet = D_3
Depth above Contraction, in Feet = D_1
$H_2/D_3 = 0.1$
$H_2/D_3 = 0.2$
$H_2/D_3 = 0.3$
$H_2/D_3 = 0.4$
$H_2/D_3 = 0.5$
$H_2/D_3 = 0.6$
$H_2/D_3 = 0.7$
$H_2/D_3 = 0.8$

FIG. 6.

to find the value of D_2 which gives the maximum discharge, it is found that this occurs when D_2 is equal to $\frac{2}{3} D_1$, or when H_2 is equal to $\frac{1}{2} D_2$, or $\frac{1}{3} D_1$. The maximum discharge, therefore, is:

$$Q = C_{dA} W_2 \frac{2}{3} D_1 \sqrt{2 g \frac{D_1}{3}} \quad \ldots\ldots\ldots\ldots (9)$$

$$= C_{dA} W_2 3.09 D_1^{\frac{3}{2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (10)$$

In flowing, on a level bottom, from a body of water at one elevation to another at a lower elevation, where D_3 is less than $\frac{2}{3} D_1$, the water tends to assume the condition of maximum discharge, and flow in the same manner as if D_3 were equal to $\frac{2}{3} D_1$. This phenomenon was pointed out by Unwin* and Frizell† and has been described before the Society.‡

From Fig. 5, it will be seen that all those runs which give the d'Aubuisson coefficients greater than unity, have $\frac{H_3}{D_3}$ greater than 0.5. This is also shown on Fig. 7, where the d'Aubuisson coefficients are plotted against the ratio, $\frac{H_3}{D_3}$. The flow in these cases, therefore, was similar to the condition of maximum discharge and had a depth in the most contracted section of, approximately, $\frac{2}{3} D_1$. The theoretical discharge according to the d'Aubuisson formula was computed on the assumption that the depth of the stream in the most contracted section was equal to D_3, the depth in the pool below the contraction. For those runs in which D_3 was less than $\frac{2}{3} D_1$, D_3 was less than D_2, and the computed discharge, therefore, was less than the actual discharge, causing coefficients greater than unity. For this reason, the d'Aubuisson formula should not be used where $D_3 < \frac{2}{3} D_1$, unless the value of D_2 is actually measured and used in the computations.

* *Encyclopedia Britannica,* under "Hydrodynamics".
† "Water Power", by Frizell, pp. 198-200.
‡ *Transactions,* Am. Soc. C. E., Vol. LXXX, p. 338.

If one computes a coefficient, C_M, showing the ratio of the actual discharge to the "maximum" discharge, $Q = 3.09\ W_2\ D_1^{\frac{3}{2}}$, for those runs in which H_3 is greater than $\frac{1}{2}\ D_3$, it will be found that, in some cases, C_M is greater than unity, or that the actual discharge was greater

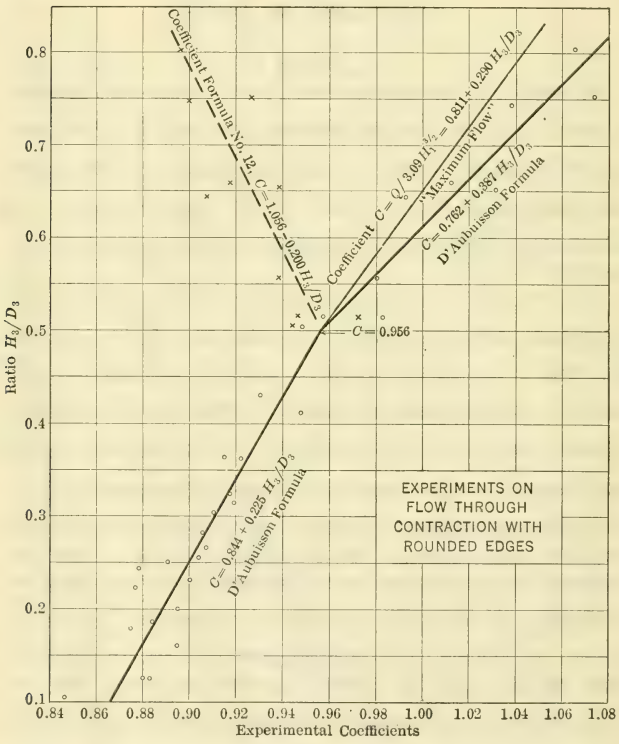


FIG. 7.

than the maximum possible, according to this theory. Here, again, an examination of the condition of flow shows the reason for this discrepancy. The conditions which give rise to the "maximum flow" are shown on Fig. 8, the cross-hatched area representing graphically

the discharge per unit width. In this case, $D_2 = D_3 = \frac{2}{3} D_1$. In those cases where the coefficient, C_M, is greater than unity, D_3 is less than $\frac{2}{3} D_1$, and the conditions of flow are as shown on Fig. 9.

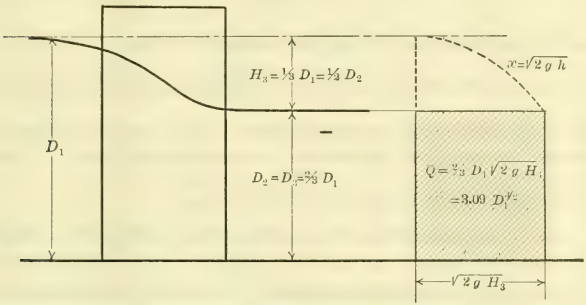


FIG. 8.

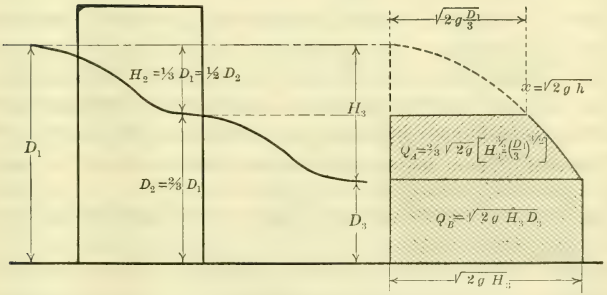

$\sqrt{2 g \frac{D_1}{3}}$
$H_2 = \frac{1}{3} D_1 = \frac{1}{2} D_2$
$x = \sqrt{2 g h}$
H_3
D_1
$D_2 = \frac{2}{3} D_1$
$Q_A = \frac{2}{3} \sqrt{2 g} \left[H_3^{3/2} - \left(\frac{D_1}{3}\right)^{3/2} \right]$
D_3
$Q_B = \sqrt{2 g H_3} D_3$
$\sqrt{2 g H_3}$

FIG. 9.

Under these conditions, all those particles of water which flow through the contraction below the elevation of the down-stream water surface, have a velocity due to the difference of elevation of the water surface above and below the contraction, or $\sqrt{2 g H_3}$. They make up the lower cross-hatched rectangle of Fig. 9, with an area of $D_3 \sqrt{2 g H_3}$. Those particles which pass out of the contraction at an elevation above

the lower pool, have a velocity, depending on their elevation, varying from $\sqrt{2\,g\,\frac{D_1}{3}}$ to $\sqrt{2\,g\,H_3}$, the total discharge through this section being

$$W_2\,\frac{2}{3}\,\sqrt{2\,g}\,\left[H_3^{\frac{3}{2}} - \left(\frac{D_1}{3}\right)^{\frac{3}{2}}\right] \ldots\ldots\ldots\ldots\ldots (11)$$

and the total discharge through the contraction being

$$Q = C\,W_2\,\sqrt{2\,g}\,\left[D_3\,H_3^{\frac{1}{2}} + \frac{2}{3}\left(H_3^{\frac{3}{2}} - \left\{\frac{D_1}{3}\right\}^{\frac{3}{2}}\right)\right] \ldots\ldots (12)$$

This formula, as will be shown later, is only applicable where the flowing stream has an opportunity to expand laterally when, or shortly after, it reaches the point where its depth is $\frac{2}{3}\,D_1$.

Fig. 7 shows graphically the results of the experiments on the contraction with curved entrance, the values of the coefficients being plotted against the values of the ratio, $\frac{H_3}{D_3}$. It will be seen that the values of the coefficient seem to be dependent on this ratio, that is, all cases having the same value of $\frac{H_3}{D_3}$ have the same coefficient. This fact makes it possible to obtain a simple formula for the coefficient of these experiments, as it combines the two variables, D_1, the depth above, through the relation $D_1 = H_3 + D_3$, with D_3, the depth below, into a single variable. The results show that the coefficients in the d'Aubuisson formula increase at a uniform rate, with respect to the values of $\frac{H_3}{D_3}$, until the depth of maximum flow is reached, or where $H_3 = 0.5\,D_3$. For the values of $\frac{H_3}{D_3}$ up to 0.5 the coefficient can be expressed by the formula, $C = 0.844 + 0.225\,\frac{H_3}{D_3}$. Above this critical depth, the coefficient increases at a rapid rate, soon becoming greater than unity, for the reason already explained. This portion also seems to follow a straight line law, with a formula, $C = 0.762 + 0.387\,\frac{H_3}{D_3}$. If the formula, $Q = C_M\ 3.09\ W_2\ D_1^{\frac{3}{2}}$, is used for the discharge, where $\frac{H_3}{D_3} > 0.5$, the coefficients follow a line as shown, which differs little from that of the d'Aubuisson formula. This coefficient also

becomes greater than unity, as previously explained. The experimental points were not put on the diagram, in order to avoid confusion, as many of them fall close to those of the d'Aubuisson formula. This curve has a formula, $C = 0.811 + 0.290 \frac{H_3}{D_3}$. The coefficients determined by Formula (12), for runs where $\frac{H_3}{D_3} > 0.5$, also seem to follow a straight line, decreasing uniformly as the ratio, $\frac{H_3}{D_3}$, increases, according to the equation, $C = 1.056 - 0.200 \frac{H_3}{D_3}$. Algebraically, if the formula for $C_{d.1}$ follows a straight line, those for C_M and the coefficient for Formula (12) do not necessarily follow straight lines. Practically, however, the straight line relation seems to fit all three cases.

From the results of the experiments on the short flume with rounded entrance and on the expanding flume, it seems probable that the difference between the theoretical and actual discharge of the contraction with rounded edges is due to a loss of the nature of an impact rather than a friction loss. The increase of the coefficient, $C_{d.A}$, as the value of $\frac{H_3}{D_3}$ increases, shows that this loss becomes a relatively smaller portion of the head, as the value of $\frac{H_3}{D_3}$ increases. The variability of the coefficient may be in part due to a slight recovery of the elevation head of the water after passing through the contraction. Such a recovery occurred in the short flume with rounded entrance, as will be explained later, but the measurements on the contraction with rounded edges were not of such a nature that its presence, if it existed, could be shown. The phenomenon of change from stream line to turbulent flow may also be a contributing factor. It has been suggested that this change of state of motion of the water is responsible for certain phenomena of flow over a sharp crested weir at low heads.*

The decrease in the coefficient for Formula (12), where $\frac{H_3}{D_3} > 0.5$, may be due to an assumption on which the formula is based, which may be only approximately true, namely, that when $\frac{H_3}{D_3} > 0.5$, H_2, the water

* "Control of Water", by Parker, p. 22.

surface drop in flowing through the contraction, is always equal to $\frac{1}{3} D_1$. This is probably true when $D_3 = \frac{2}{3} D_1$, but a somewhat different set of conditions exist when $D_3 < \frac{2}{3} D_1$, which may cause the drop of the water surface to follow a slightly different law. Just what this law is would probably have to be determined by measurement. H_2 would probably not be a constant proportion of D_1, but would probably start at $\frac{1}{3} D_1$, when $\frac{H_3}{D_3} = 0.5$ and, as the decreasing coefficients seem to indicate, become a larger part of D_1 as the ratio, $\frac{H_3}{D_3}$, increases.

Sharp Edge Contractions.—The results of the experiments on the sharp edge contractions are given in Tables 2 and 3. It will be noticed that for both, the 1 and 2-ft. widths, the values of the coefficients are practically constant for the Weisbach formula, while, for the d'Aubuisson formula, they vary over quite a range. Moreover, the value of the coefficient in the Weisbach formula is in fair agreement with the values found on the sharp edge weir and orifice. If the conditions of flow at these contractions are examined, it is evident that, for this case, the Weisbach, rather than the d'Aubuisson, formula is the rational one. The reason for this is evident from a study of Fig. 2. In the case of the contraction with rounded edges, where $H_3 < \frac{1}{2} D_3$, all the drop takes place within the contraction. Each particle of water, therefore, acquires a velocity depending on the difference of the water level above and below the contraction, or $\sqrt{2 g H_3}$, and the total discharge is, therefore, $Q = W_2 D_3 \sqrt{2 g H_3}$. In the sharp edge contraction, however, the greater part of the drop takes place after the water has passed through the contraction. (Fig. 3.) Each particle above the tail-water level, as it passes through the contraction, has a velocity in proportion to its drop, or to $\sqrt{2 g h}$, and the discharge per unit width of this portion is:

$$\int_0^{H_3} \sqrt{2 g h} = \frac{2}{3} \sqrt{2 g} H_3^{\frac{3}{2}}.$$

All the particles below the tail-water level have the same velocity, or $\sqrt{2 g H_3}$, and the discharge per unit width of this portion is

$D_3 \sqrt{2\,g\,H_3}$. Combining these two parts, we have the Weisbach formula:

$$Q = C_W\, W_2 \sqrt{2\,g} \left(\frac{2}{3} H_3^{\frac{3}{2}} + D_3\, H_3^{\frac{1}{2}} \right).$$

As H_3 and D_3 were actually measured and used in the computations of the results of the sharp edge contractions, it will be seen that if H_3 and D_3 are used in place of H_2 and D_2, the flow through the sharp edge contraction agrees with the Weisbach theory. The Weisbach formula is essentially the same as the theoretical formula for a submerged weir, and the condition of flow through a sharp edge contraction is similar to that which theoretically takes place over such a weir. In all cases of flow through contractions, the individual water particles follow the Bernouilli theorem, and if the area of the stream from the sharp edge contraction was measured where it reaches the elevation of the down-stream pool, the discharge no doubt would be found to be $Q = A \sqrt{2\,g\,H_3}$, where A represents this area.

The Weisbach coefficients for the sharp edge contractions are not exactly constant, but vary slightly, being larger for the smaller values of $\frac{H_3}{D_3}$. This might indicate that the coefficients for the two portions (Formulas (2) and (3)) have different values, instead of the same value, which is an assumption of the Weisbach formula. The formula on this basis, therefore, would be :

$$Q = W_2 \sqrt{2\,g} \left[C_A \frac{2}{3} H_3^{\frac{3}{2}} + C_B\, D_3\, H_3^{\frac{1}{2}} \right] \ldots\ldots\ldots (14)$$

The coefficients in this formula may be readily found by transferring Formula (14) into

$$Q = \left(\frac{2}{3} C_A \frac{H_3}{D_3} + C_B \right) W_2 \sqrt{2\,g}\, D_3\, H_3^{\frac{1}{2}}$$

It will be recognized that this has the same form as the d'Aubuisson formula, except in this case the coefficient is a variable composed of two parts, one of which is a constant, while the other is a linear function of $\frac{H_3}{D_3}$. If, therefore, the d'Aubuisson coefficients of these experiments are plotted against their respective values of $\frac{H_3}{D_3}$ (Fig. 10), and the straight line most nearly representing the points is drawn, we have directly the

values of C_B and C_A, C_B being the value of the d'Aubuisson coefficient, as shown by this line, when $\frac{H_3}{D_3} = 0$, and C_A being $\frac{3}{2}$ of the slope of the line with respect to the axis along which the values of the ratio, $\frac{H_3}{D_3}$, were plotted.

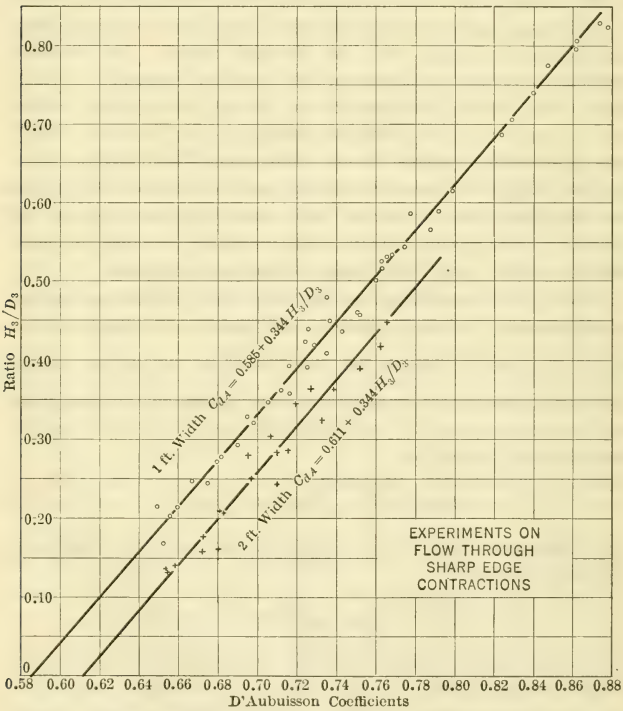


FIG. 10.

Fig. 10 shows the results of this plotting for both the 1-ft. and 2-ft. widths, and the d'Aubuisson forms thus derived for the discharges are:

$$Q = \left[0.585 + 0.344\,\frac{H_3}{D_3}\right] W_2 \sqrt{2g}\, D_3\, H_3^{\frac{1}{2}} \ldots\ldots\ldots (16)$$

for the 1-ft. width, and

$$Q = \left[0.611 + 0.344 \frac{H_3}{D_3}\right] W_2 \sqrt{2g}\, D_3\, H_3^{\frac{1}{2}} \ldots\ldots\ldots (17)$$

From these, the coefficients in Formula (14) are, therefore, for the 1-ft. width, $C_B = 0.585$, and $C_A = \frac{3}{2} \times 0.344 = 0.516$, and for the 2-ft. width, $C_B = 0.611$ and C_A also $= 0.516$.

It will be noticed that the coefficient for that part of the flow below the tail-water elevation is larger than that for the part above. The reason for this is probably because the portion below is contracted on two sides only, while that above is contracted on both sides and top, since the upper surface, as it flows through the contraction, has already dropped a certain quantity and does not remain at the elevation of the head-water, as assumed in the Weisbach formula. This tends to cause a greater contraction in the upper part of the stream and, therefore, produces a lower coefficient for this part.

The coefficient, C_A, for both widths is found to be the same, but as the range covered by the experiments on the 2-ft. width was small, due to the limitations of the apparatus, the values are not clearly defined, and experiments covering a larger range might show them to differ slightly. The writer believes that the same coefficient in the two cases is the result of a balance of the effects of the contraction on the sides and upper surface of this part of the flow. The effect of the contractions on the sides is less for the larger width, as is shown by the greater coefficient for that width, for the portion of the stream below the tail-water level. On this part only the side contractions are acting. The contraction due to the drop of the water surface before passing between the sharp edges is probably less for the narrow width, since the contraction of the stream at the sides tends to prevent this surface drop from taking place. The effect of these side contractions is greater on the narrower width, since, in this case, they occupy a greater proportion of the width of the opening. The tendency of the contraction on the sides of the 1-ft. width to be larger, and on the top to be smaller, than for the 2-ft. width, probably equalize each other, and give the same coefficients on both widths.

The flow in the section of the contraction above the tail-water level is probably somewhat similar to that through a rectangular weir with

end contractions. The late James B. Francis, Past-President, Am. Soc. C. E., found that the effect of the end contractions was to reduce the effective length of the weir by 0.2 H. His formula, however, if carried to extremes, leads to a negative discharge, and experiments* show that although it is applicable up to a certain point, for widths narrower than this, the end contractions interfere in the center, and the reduction of the effective length becomes less than 0.2 H. The discharge, therefore, tends to become more like that through an orifice. As it seems reasonable that, for a very large width, the discharge of a sharp edge contraction would be practically the same as for one with rounded edges, one would expect that, as the width of the contraction was increased, the coefficient, C_B, would increase, while C_A would decrease.

Different coefficients for the parts of the flow above and below the tail-water level have been found for the flow over a submerged weir. Mr. Francis† found the coefficients for a submerged weir without end contractions to be 0.622 and 0.573 for the part above and below the tail-water, respectively. For the part above, the coefficient for the weir is larger than that of the contraction. This is probably due to the fact that, in the case of the weir, the coefficient expresses the effect of the surface drop only, while, in the case of the contraction, it is due to both the surface drop and the effect of the sides. On the other hand, for the part below the tail-water level, the coefficient for the weir is slightly smaller than for the contractions, indicating that the effect of the sides of the contraction is less than that of the crest of the weir.

General Formula for Contractions.

A general formula for contractions may be developed in a manner similar to Formula (12), by using the water surface drop, H_2, instead of $\frac{1}{3} D_1$. This formula is

$$Q = C_G \; W_2 \sqrt{2\,g} \left[D_3 \, H_3^{\frac{1}{2}} + \frac{2}{3} \left(H_3^{\frac{3}{2}} - H_2^{\frac{3}{2}} \right) \right] \ldots\ldots (18)$$

When the conditions are such that all the drop takes place after the water passes through the contraction, H_2 is zero, and the formula

* *Cornell Civil Engineer*, April, 1912.

† *Transactions*, Am. Soc. C. E., Vol. XIII, p. 303.

becomes the same as that used in computing the Weisbach coefficients. When the drop takes place within the contraction, H_2 is equal to H_3, and the formula becomes that used in the computation of the d'Aubuisson coefficients. In order for this formula to apply, it is necessary for the flowing stream to be able to expand laterally without hindrance immediately after passing through the narrowest portion of the contraction, which limits the use of the formula to contractions the lengths of which in the direction of flow, are rather short. The reason for this will be shown in the discussion of the results of the experiments on short flumes. It is evident, therefore, that the sharp edge contraction, where very little drop takes place before the water passes between the sharp edges, is the condition most favorable to the application of the Weisbach formula, while the contraction with a gradually decreasing width, where all the water surface drop has taken place before the water passes the narrowest section, is the most favorable for the d'Aubuisson formula. For conditions between, where part of the drop takes place before the water reaches the most contracted section, and part occurs after this point is passed, the general formula applies. The contraction with rounded edges, where $H_3 > \frac{1}{2} D_3$, falls in this latter case, the value of H_2 not being the constant, $\frac{1}{3} D_1$, as in Formula (12), but a variable, as indicated on page 742.

The coefficient, C_G, of the general formula considers only the contraction at the sides, since the contraction at the upper surface is taken care of by the term, H_2. One would expect, therefore, that this coefficient would have substantially the same value as that for orifices with the same class of edges. Thus, for those cases where the entrance is formed by gradual curves, this coefficient would approach unity, while, for sharp edges, it would approach the coefficient of a sharp edge orifice.

It may be reasonably assumed that, except for the contraction of that part of the stream above the tail-water level, due to the drop of the water surface before passing through the contraction, C_A and C_B in Formula (14) would be equal. If this is true, the term, H_2, in the general formula, accounts for the difference between C_A and C_B, and the coefficient, C_G, of the general formula should be equal to C_B, since

each is the coefficient due to contraction at the sides only. Assuming $C_G = C_B$, by equating Formulas (14) and (18), we have

$$C_G\left[H_3^{\frac{3}{2}} - H_2^{\frac{3}{2}}\right] = C_A\ H_3^{\frac{3}{2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (19)$$

or,

$$\frac{H_2}{H_3} = \left[\frac{C_G - C_A}{C_G}\right]^{\frac{2}{3}} = \left[\frac{C_B - C_A}{C_B}\right]^{\frac{2}{3}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (20)$$

From these assumptions, it follows, therefore, that the drop in the water surface at the "crest" of the sharp edge contraction is a constant proportion of the total drop. By inserting the values of C_A and C_B in Formula (20), $\frac{H_2}{H_3}$ is found to be 0.240 for the 1-ft. width, and 0.298 for the 2-ft. width. This agrees with the statement on page 745 that the surface drop is greater for the 2-ft. contraction. In having the surface drop a constant proportion of the total drop, the contraction resembles the weir, the surface drop at the crest of which has been found to be a constant proportion of the head.*

Results on Experimental Flumes.

Short Flume with Rounded Entrance.—The results of the experiments on the short flume with rounded entrance are given in Table 4 and are shown by Figs. 11, 12, and 13.

The author regrets that he was prevented from completing the series of experiments on this flume, which he had planned, but as these few experiments throw considerable light on the theory of flow through a contraction, they will be fully described. The coefficients at the various observing sections for both the d'Aubuisson and Weisbach formulas are plotted at their respective distances from the entrance. A profile is given, showing the mean surface of the water as it flows through the flume. At each point along this profile is also shown the velocity head of the water at that point and the head lost in friction up to that point, which is, of course, the difference between the actual drop of the water and that part of this drop which is transformed into velocity. A line is also drawn showing at all sections the critical depth for a stream flowing with the velocity existing at that section.

An interesting difference between the flow through the short flume with rounded entrance and the contraction with rounded edges will be

* "Expériences Nouvelles sur l'Ecoulement en Deversoir exécutées a Dijon de 1886 a 1895", H. Bazin, 1898. Translated by A. Marichal and J. C. Trautwine, Jr., Assoc. Am. Soc. C. E., in the *Proceedings* of the Engineers' Club of Philadelphia.

noticed. At the end of the entrance section of the short flume, the surface drop is considerably less than the maximum drop in the flume. Although no actual measurements were made of the surface drop in the contraction with rounded edges, except in a few runs, no material drop was observed in the water surface after passing through the contraction. A possible cause of this difference is the constraining effect

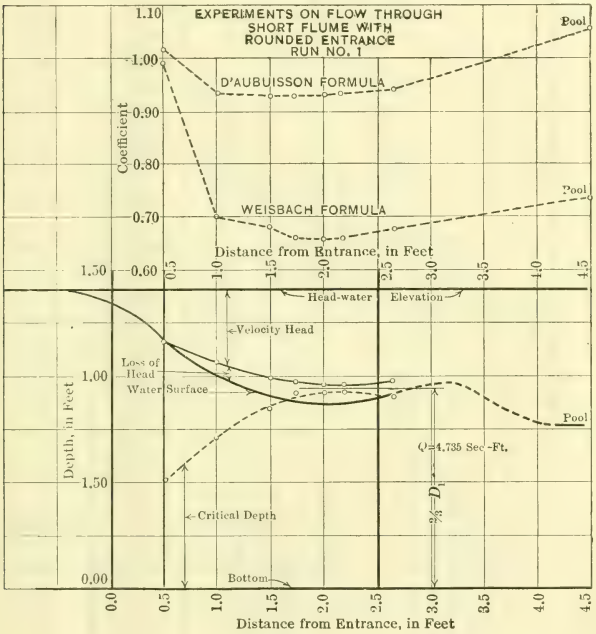


FIG. 11.

of the sides of the flume. In flowing through the contraction with rounded edges, or the entrance section of the flume, the water surface drops, and the water particles near it flow in a downward direction. Those near the bottom, however, flow horizontally. Because of their inertia, the particles tend to maintain their direction after passing through the converging portion. The path of the particles from above

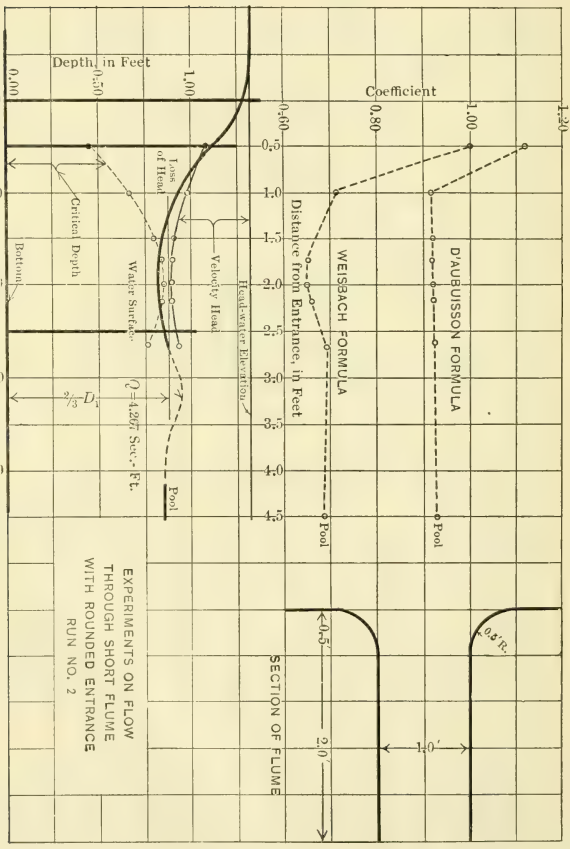

Coefficient
0.80
1.00
1.20
D'AUBUISSON FORMULA
WEISBACH FORMULA
Pool
Pool
Distance from Entrance, in Feet
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
0.2 R.
0.5
2.0
1.0
SECTION OF FLUME
Depth, in Feet
0.00
0.50
1.00
Loss of Head
Velocity Head
Head-water Elevation
Water Surface
Critical Depth
Bottom
Pool
$Q = 4.97$ Sec.-Ft.
$\frac{2}{3} D$
EXPERIMENTS ON FLOW
THROUGH SHORT FLUME
WITH ROUNDED ENTRANCE
RUN NO. 2
Distance from Entrance, in Feet
0.0
1.0
2.0
3.0
4.0

FIG. 12.

intersects that of those from below, and each group tends to be deflected somewhat from the original direction. In the case of the contraction, the particles in the bottom portion are deflected laterally, while those above are given a more nearly horizontal direction. In the flume, however, because of the constraining effect of the sides, the lower

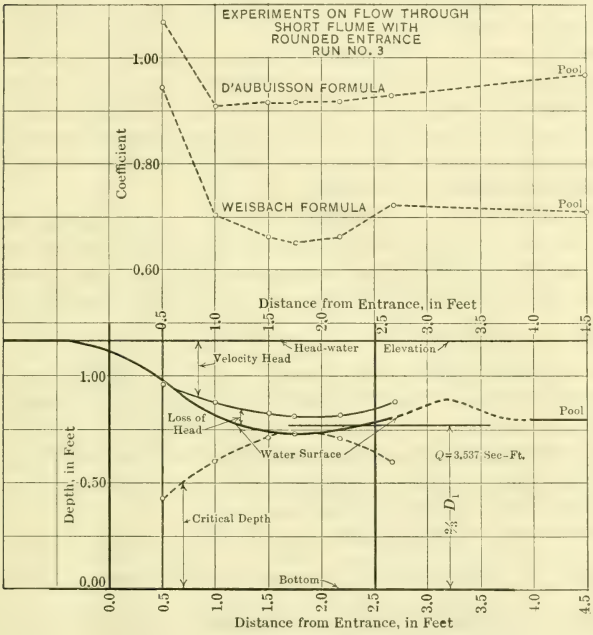


FIG. 13.

particles must continue in a horizontal direction and the particles above, therefore, cannot drop as rapidly as they would if those below could be deflected. The particles above, therefore, gradually acquire a more nearly horizontal flow as they pass down the flume, the lowest point in the water surface being reached some distance down stream from the entrance.

The coefficients of both formulas are found to have high values at the first measuring section of the short flume with rounded entrance. The condition of flow in this case is similar to that for which the general formula for contractions (Formula (18)) was derived, and, therefore, gives a high value of the coefficient when the assumption is made that the total drop is the same as the water surface drop at that point. Neglecting this first measuring point, the d'Aubuisson coefficients average about 0.92, while those of the Weisbach formula average approximately 0.67. Here, again, as in the contraction with rounded edges, one would expect the coefficient of the true formula to have values of nearly unity, which points to the d'Aubuisson formula as being the true one for this case. Experiments on the expanding flume indicate that the d'Aubuisson coefficients for other discharges would not necessarily remain 0.92.

The d'Aubuisson coefficients for the point 2 ft. below the end of the contraction vary, being greater than unity for Run No. 1. As explained on page 728, the width of the flowing stream at this point was assumed to be the same as that of the lower end of the flume. Since, in Run No. 1, the depth in the pool below the contraction, was less than $\frac{2}{3} D_1$. the theoretical discharge which would result from the assumptions made on the basis of the d'Aubuisson formula, would be considerably less than the maximum possible flow through the contraction. As the actual discharge was very close to this maximum, it was greater than the theoretical discharge as computed by the d'Aubuisson formula, and, therefore, the coefficient is greater than unity.

In all three experiments, the drop in the flume is found to be practically $\frac{1}{3} D_1$. For Run No. 1, the depth of the tail-water is less than $\frac{2}{3} D_1$, and the water in flowing through the flume takes practically the depth which will give maximum discharge, or $\frac{2}{3} D_1$. That it does not take exactly this depth may be accounted for perhaps by the fact that, in spite of the smooth curves of the rounded entrance, there was some disturbance as the water entered the flume, and a considerable entrance loss, as is shown by the loss of head at the 1.0-ft. point. In Runs Nos. 2 and 3, the drop is also practically $\frac{2}{3} D_1$, although D_3 is slightly greater

than D_2. This would indicate a slight recovery of head, or change from velocity to elevation head, of the water after leaving the flume. This seems to have been accomplished in a stationary wave which occurred at the lower end of the flume. Just how much of the velocity head of the water can be recovered in the form of elevation head in this way cannot be determined from these experiments, but, in both cases in which it occurred, the recovery was slight. That the drop of the water surface in the flume should be practically $\frac{1}{3} D_1$ for cases where the depth of the tail-water is much greater than $\frac{2}{3} D_1$, is not to be expected.

In the short flume with rounded entrance, where the water reaches the depth $\frac{2}{3} D_1$ some distance up stream from the lower end, it is not possible for the flow to exceed $3.09\ W_2\ D_1^{\frac{3}{2}}$, as was the case for the contraction with rounded edges, as no expansion of the jet is possible immediately after the stream passes the lowest point within the contraction. The derivation of the theory, according to which the maximum flow is $3.09\ W_2\ D_1^{\frac{3}{2}}$, is based on the Bernouilli theorem, which, for open channels, assumes that each particle of water is subjected to a static pressure equal to the weight of the particles above it, up to the free water surface. When this condition does not exist, the maximum flow does not occur when the drop is $\frac{1}{3} D_1$. When the stream is free to expand laterally, its sides, as well as its upper surface, are at atmospheric pressure, and, therefore, all the particles within it are not subjected to the full static pressure due to the height of the water above them. Just how far up stream the effect of the reduction of pressure on the sides extends, is not easily determined, but it is probably dependent on the magnitude of this reduction. For small models such as those experimented on, it probably causes appreciable effect only a short distance above. From the foregoing, it will be seen that where the stream is free to expand after it passes the narrowest section, as in the contraction with rounded entrance, the discharge can exceed the "maximum", but in the short flume with rounded entrance, where the water surface reaches its lowest point some distance above the end of the flume, the "maximum" cannot be exceeded.

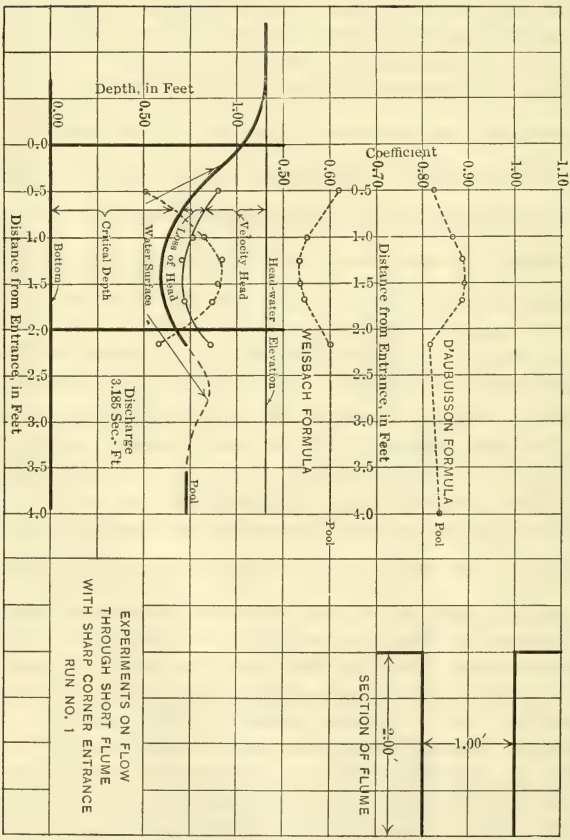

EXPERIMENTS ON FLOW
THROUGH SHORT FLUME
WITH SHARP CORNER ENTRANCE
RUN NO. 1
SECTION OF FLUME
1.00′
2.00′
D'AUBUISSON FORMULA
Pool
WEISBACH FORMULA
Pool
Coefficient
0.70
0.80
0.90
1.00
1.10
0.50
0.60
Distance from Entrance in Feet
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Depth, in Feet
0.00
0.50
1.00
Head-water Elevation
Velocity Head
Loss of Head
Water Surface
Critical Depth
Bottom
Pool
Discharge
3.186 Sec.-Ft.
Distance from Entrance, in Feet

FIG. 14.

Figs. 11, 12, and 13 show that the loss of head which occurs in the stream as it flows through the flume increases very little after the drop of the water surface is practically complete. This indicates that the loss took place in the curved entrance, and was, therefore, more of the nature of an entrance or impact loss, than a friction

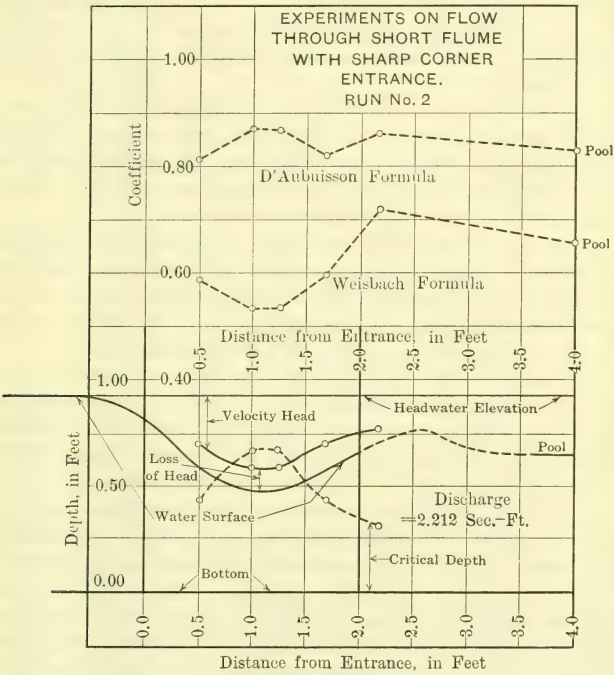


FIG. 15.

loss. If it was caused by friction, it would probably be greater in the narrow portion of the flume and would increase as the water passed down the flume.

Short Flume with Sharp Corners.—The results of the experiments on the short flume with sharp corners are given in Table 5 and shown on Figs. 14 and 15. The d'Aubuisson coefficients are fairly constant,

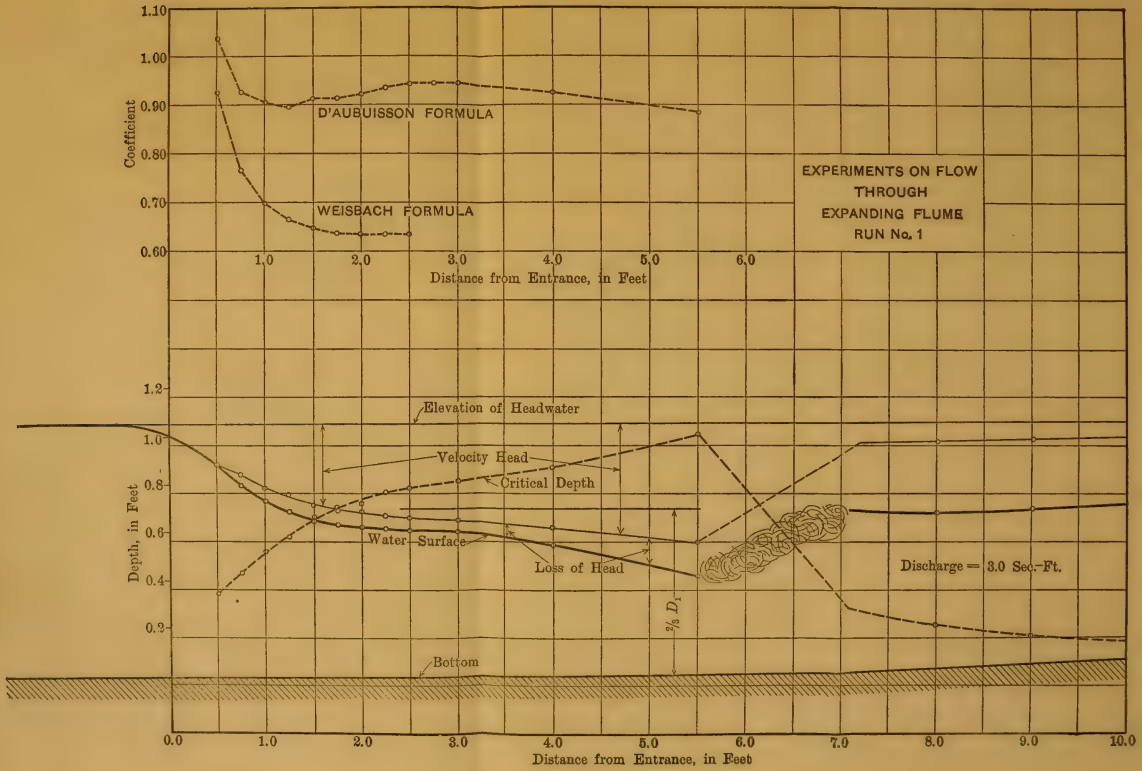
being between 0.80 and 0.90, while those of the Weisbach formula vary over a wide range. The d'Aubuisson coefficients are higher than one at first would expect, but it will be noticed that they are based on the actual area of flow, and, therefore, include the influence of the contraction resulting from the sharp corners only in so far as these introduce a somewhat turbulent state and thus cause internal friction and impact losses. This fact should always be kept in mind in estimating the flow through a contracted opening by the use of the d'Aubuisson formula.

The water surface in the flume fell below the critical depth for a stream having its velocity and, therefore, in order to reach the depth of the tail-water, formed a hydraulic jump. On account of the disturbed flow in this type of flume, the hydraulic jump was poorly defined, and did not take the form usually seen in such jump.

Expanding Flume.—The experiments on the expanding flume consisted of measurements under five conditions of head-water and tail-water, but all with approximately the same discharge. In view of the many interesting features of this flume, the writer regrets that he was unable to make a more complete series of experiments on it.

The results of the individual runs are shown on Tables 6 to 10, inclusive, and on Plates XIII to XVII, inclusive, while a section of the flume, profiles of the water surface to natural scale, and the d'Aubuisson coefficients, for all runs, are shown on Plate XVIII. Views of two conditions of flow are shown on Figs. 16 and 17.

It will be seen that, for the first three runs, the d'Aubuisson coefficients in the prismatic section of the flume, are subject to less variation than those of the Weisbach formula, which indicates that the d'Aubuisson formula is the true one for this case. This coefficient in the prismatic section of the flume for Runs Nos. 1 to 3, varies little from 0.92, which was found to be the coefficient for similarly located points in the short flume with rounded entrance. As the expanding flume can be formed from the short flume with rounded entrance by adding the expanding portion, this agreement of the coefficients indicates that that portion has little influence on the flow through the narrow section of the flume. The high coefficient and negative loss of head at the 0.5-ft. point, and the great loss of head at the entrance, which occur in this flume, as in the short flume with rounded entrance, also point to this conclusion.


Coefficient
1.10
1.00
0.90
0.80
0.70
0.60
D'AUBUISSON FORMULA
WEISBACH FORMULA
1.0
2.0
3.0
4.0
5.0
6.0
Distance from Entrance, in Feet
EXPERIMENTS ON FLOW THROUGH EXPANDING FLUME
RUN No. 1
Depth, in Feet
1.2
1.0
0.8
0.6
0.4
0.2
Elevation of Headwater
Velocity Head
Critical Depth
Water Surface
Loss of Head
⅔ D_1
Discharge = 3.0 Sec.-Ft.
Bottom
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
Distance from Entrance, in Feet

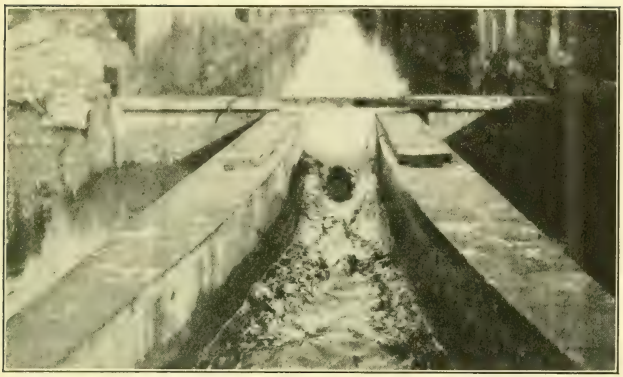


FIG. 16.—EXPANDING FLUME, RUN NO. 3.

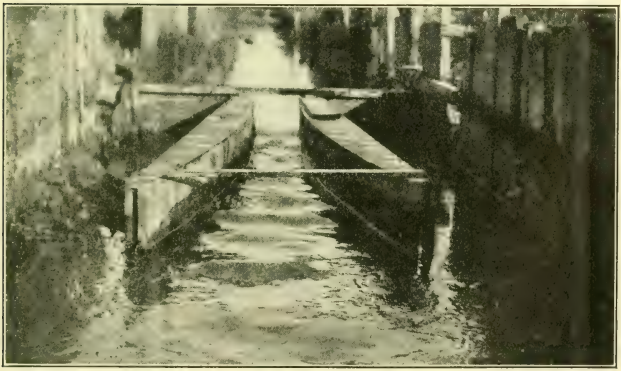
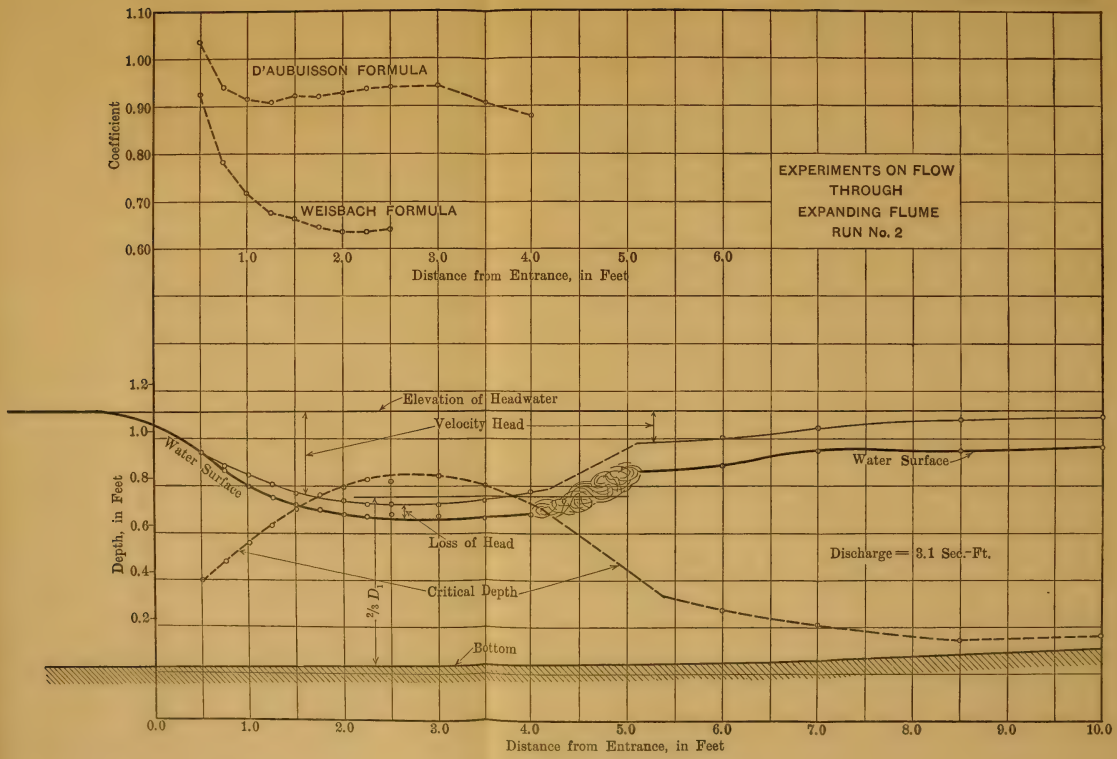


FIG. 17.—EXPANDING FLUME, SHOWING FORMATION OF STATIONARY WAVES.


Coefficient
1.10
1.00
0.90
0.80
0.70
0.60
D'AUBUISSON FORMULA
WEISBACH FORMULA
1.0
2.0
3.0
4.0
5.0
6.0
Distance from Entrance, in Feet
EXPERIMENTS ON FLOW
THROUGH
EXPANDING FLUME
RUN No. 2
Depth, in Feet
1.2
1.0
0.8
0.6
0.4
0.2
Elevation of Headwater
Velocity Head
Water Surface
Water Surface
Loss of Head
Discharge = 3.1 Sec.-Ft.
Critical Depth
⅔ D1
Bottom
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
Distance from Entrance, in Feet

In Runs Nos. 4 and 5, and to a less extent in Run No. 3, the wave formation in the flume made the determination of the coefficients difficult. These waves were stationary, maintaining the same location in the flume, and smooth, resembling wind waves on a deep body of water. A further resemblance to wind waves was shown by the formation of a stationary whitecap in Run No. 4. This formation could easily be mistaken for the hydraulic jump, but as the velocity was far below the critical value for that depth, it resulted from another cause. As will be seen in Plate XVI, this rolling water was preceded by two steep waves, and was due, no doubt, to the breaking over of the crest of a wave, when it became too steep, as in the formation of whitecaps.

In Runs Nos. 1 and 2 the drop of the water surface exceeded the theoretical drop, $\frac{1}{3} D_1$, by an appreciable amount. This is probably due to the loss of head at the entrance. The results confirm the theory of maximum flow, however, in so far as they show that the water surface under such conditions drops to a certain depth, which is independent of the depth of the water below the flume.

One of the peculiar features of this flume is that the flow through it, within certain limits, is not affected by variations in the tail-water level. The variation in discharge, depth above, and depth below, the flume, during the period in which these experiments were made, are plotted on Fig. 18, which shows that, during the first three runs, the depth above the flume varies very little, while the depth below is changed through quite a range, by the introduction of stop-logs in the channel. What variation occurs during this part of the period of experimentation, may practically all be accounted for by the variation in the discharge through the flume. When a certain tail-water depth was reached, however, this relation ceased, and any increase in the depth below, the discharge remaining the same, caused an increase in depth above the flume. This condition existed during Runs Nos. 4 and 5. The cause of these conditions can best be explained as an application of the theory of back-water curves.

The Theory of Back-water Curves as Applied to the Expanding Flume.

S. M. Woodward, M. Am. Soc. C. E., in the "Theory of the Hydraulic Jump and Back-water Curves"*, has defined a back-

* Miami Conservancy District, Technical Report, Part III.

water curve as "the profile of the surface of a stream of water in which all changes of velocity take place in accordance with Bernouilli's theorem." In that report are developed the possible cases of back-water curves in a channel of uniform width, both with and without

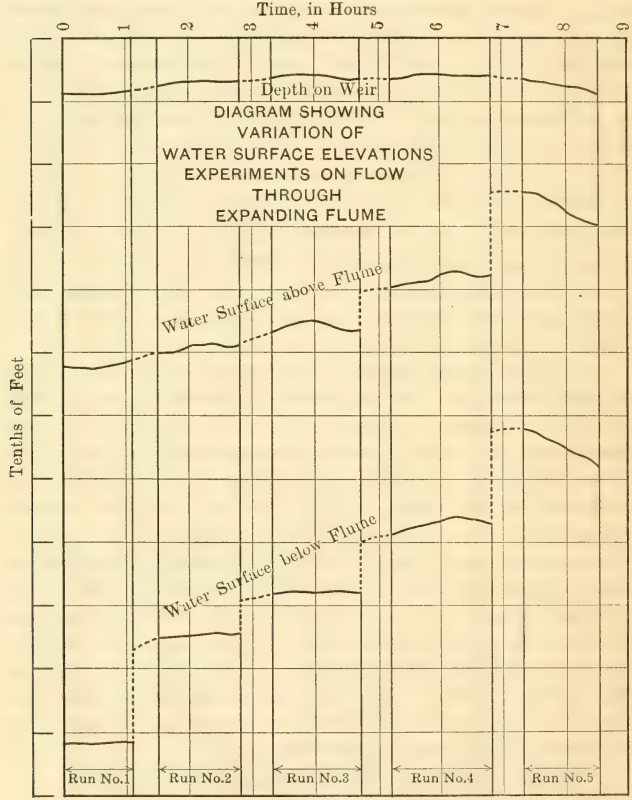
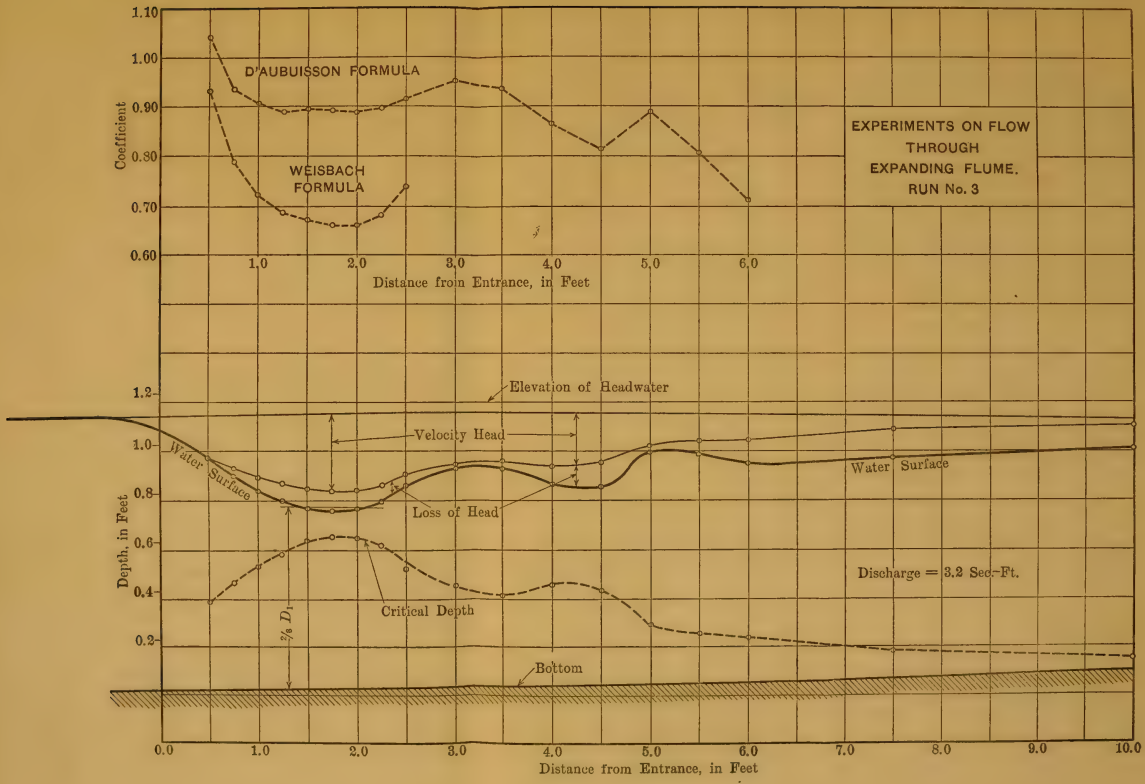


FIG. 18.

friction. As the friction loss in the expanding flume was relatively small, and as the theory of back-water curves, neglecting friction, is much simpler, the effect of friction will be neglected in this discussion.


Coefficient
1.10
1.00
0.90
0.80
0.70
0.60
D'AUBUISSON FORMULA
WEISBACH FORMULA
EXPERIMENTS ON FLOW THROUGH EXPANDING FLUME. RUN No. 3
1.0
2.0
3.0
4.0
5.0
6.0
Distance from Entrance, in Feet
Elevation of Headwater
Velocity Head
Water Surface
Water Surface
Loss of Head
Depth, in Feet
1.2
1.0
0.8
0.6
0.4
0.2
Discharge = 3.2 Sec.-Ft.
Critical Depth
½ D_1
Bottom
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
Distance from Entrance, in Feet

According to Mr. Woodward, there are five possible conditions of flow in a frictionless channel of uniform width. They are:

Case 1.—Bottom level; water surface level; any depth.

Case 2.—Bottom slopes downward; water surface slopes downward at a greater rate than the bottom; depth less than the critical value.

Case 3.—Bottom slopes downward; water surface slopes upward; depth greater than the critical value.

Case 4.—Bottom slopes upward; water surface slopes downward; depth greater than the critical value.

Case 5.—Bottom slopes upward; water surface slopes upward at a greater rate than the bottom; depth less than the critical value.

The critical value of the depth in the foregoing is that depth at which $V = \sqrt{g\,D}$.

Using an illustration given by Mr. Woodward, a similar list of possible conditions of flow in a frictionless channel of variable width, with level bottom, may be worked out. Fig. 19 represents such a channel, in which the width is varied in such a manner that with a flow of 2 000 cu. ft. per sec. entering the channel at A, and flowing toward the right, the water surface rises along the straight line, AB. The width of this channel decreases rapidly near the entrance, but less rapidly as the water surface rises, finally reaching a point of minimum width, beyond which it again increases. Any other smooth curve might be used to join the points, CDE and FGH, but, in this case, the surface profile would no longer be a straight line, but a curve. Since for all points along the channel, the sum of the velocity and elevation heads remains the same, at each point on both channels having the same surface elevation, the width would be the same.

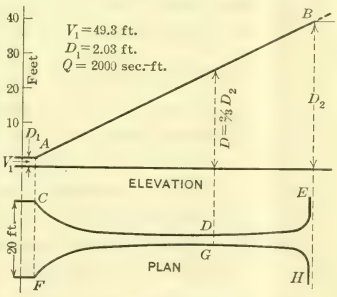


FIG. 19.

The point where the width is minimum can be found, as follows:

$$W = \frac{Q}{V\ D}$$

$$V = \sqrt{2\ g\ (D_2 - D)}$$

Differentiating, $$d\ W = d\left[\frac{Q}{\sqrt{2\ g\ (D_2 - D)}\ D^2}\right]$$

Equating to zero, and solving for D,

$$D = \frac{2}{3} D_2$$

From which, $$V = \sqrt{2\ g\left(\frac{3}{2} D - D\right)} = \sqrt{g\ D}$$

It will be seen, therefore, that the width is a minimum when the depth of the channel is at the critical value, as previously defined.

With the channel as shown in Fig. 19, the direction of flow might be reversed, the flow taking place from right to left. If the initial depth was D, and the quantity 2 000 cu. ft. per sec., as in the former case, the surface profile would be the same line, AB, the flow again being at the critical depth at the point of minimum width. In these two examples are shown the four possible conditions of flow in a frictionless channel with level bottom and variable width. They are:

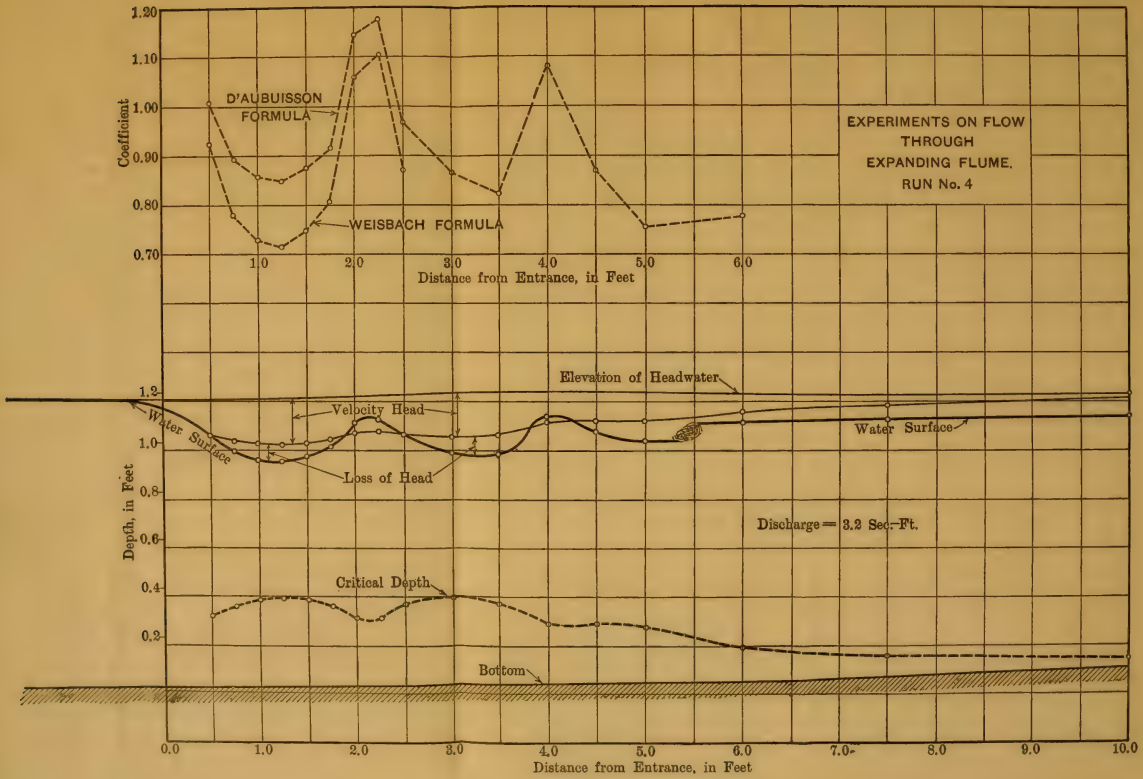
Case 1.—Width increases; water surface slopes upward; depth greater than the critical value.

Case 2.—Width increases; water surface slopes downward; depth less than the critical value.

Case 3.—Width decreases; water surface slopes upward; depth less than the critical value.

Case 4.—Width decreases; water surface slopes downward; depth greater than the critical value.

The foregoing conditions may be applied to the flow through the expanding flume. As the depth of the water below the flume is independent of the shape of the flume, we will start at this elevation. In all the experiments, this depth at the lower end of the flume was great, with respect to the velocity at that point, and was, therefore, above the critical value. On Plate XIX is shown the theoretical and actual surface profiles for Runs Nos. 1 and 4. The theoretical


Coefficient
1.20
1.10
1.00
0.90
0.80
0.70
D'AUBUISSON FORMULA
WEISBACH FORMULA
1.0
2.0
3.0
4.0
5.0
6.0
Distance from Entrance, in Feet
EXPERIMENTS ON FLOW THROUGH EXPANDING FLUME. RUN No. 4
Elevation of Headwater
Velocity Head
Water Surface
Water Surface
Loss of Head
Depth, in Feet
1.2
1.0
0.8
0.6
0.4
0.2
Discharge = 3.2 Sec.-Ft.
Critical Depth
Bottom
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
Distance from Entrance, in Feet

profile has been worked out by the step method, on the assumption that the sum of the velocity and elevation heads at all points is the same, and that there is no friction loss.

In Run No. 1, according to Case 1, in an expanding channel, if the depth is above the critical value, the water surface must slope upward, as shown by the line, AB. This condition is possible, however, only when the flow is greater than the critical depth. In sloping upward in the direction of flow, and, therefore, downward from the tail-water level, this back-water curve soon reaches the critical depth. At this point, the curve ends, as it cannot go below that depth.

A method of locating the theoretical water surface above the flume is offered by the theory of maximum flow. According to this theory, the depth above may be computed by the formula, $Q = 3.09\ W_2\ D_1^{\frac{3}{2}}$. Knowing Q and W_2, D_1 may be computed. As the depth above the flume is greater than the critical value, from Case 4, it may be concluded that, in the entrance portion of the flume, where the width is decreasing, the water surface would slope downward. On reaching the prismatic section, from Case 1 for channels of uniform width, the water surface would be level. According to the theory of maximum flow, the depth in this section would be $D_2 = \frac{2}{3} D_1$, the velocity, $\sqrt{\frac{2}{3} g\ D_1} = \sqrt{g\ D_2}$, and, therefore, equal to the critical value.

Beginning at the lower end of the prismatic section, two curves are possible. If the water surface at this point drops an infinitesimal distance, the depth is below the critical value, and, therefore, from Case 2, the water surface must slope downward. (Line CD.) On the other hand, if the surface rises an infinitesimal distance, the flow takes place at greater than the critical depth, and, according to Case 1, the water surface must rise. (Line CE.) These two curves represent the "alternative stages" discussed by Karl R. Kennison, Assoc. M. Am. C. E.* Neither of these two profiles intersect the line, AB, and, therefore, if hydraulic phenomena were confined to applications of the Bernouilli theorem, the flow of the given quantity of water through the flume, with the given tail-water level, would be impossible. No phenomenon is known by which the water surface could change from the

* *Transactions*, Am. Soc. C. E., Vol. LXXX, p. 347.

upper one of these curves and join the curve, AB, in a channel of the shape of the expanding flume. By means of the hydraulic jump, however, it is possible for the water surface to rise from the lower curve and join the curve, AB. The formula* for the hydraulic jump is:

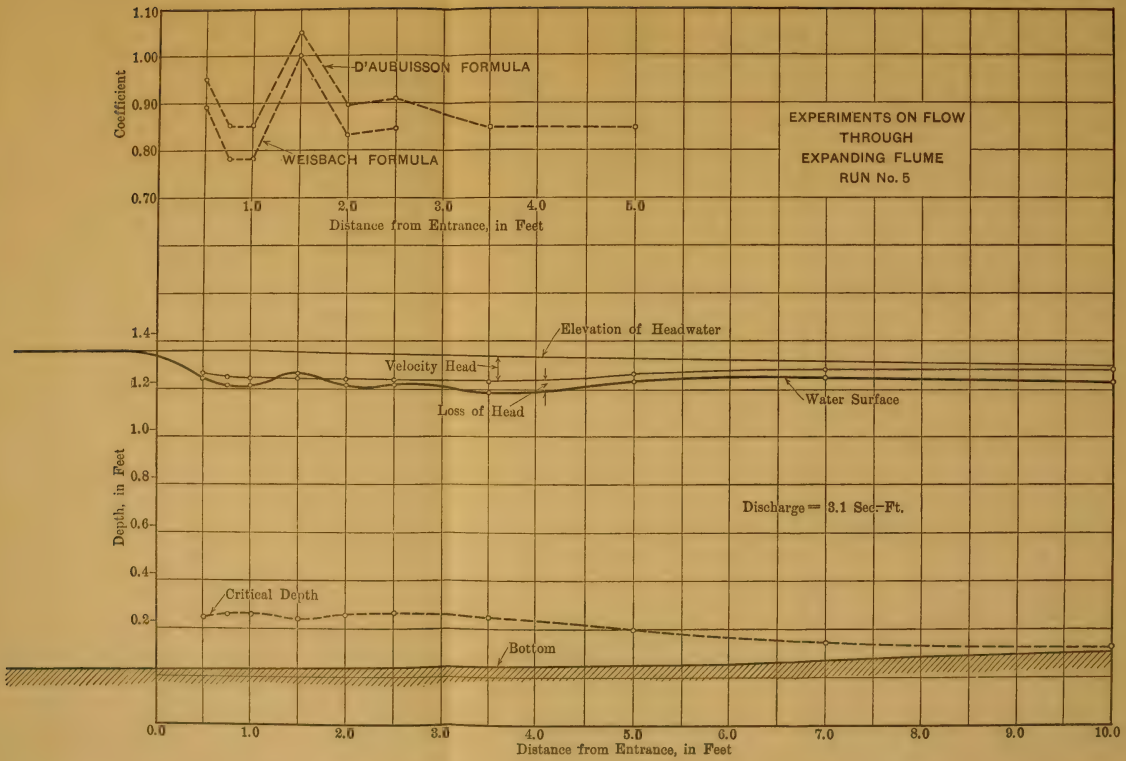
$$D_2 = -\frac{D_1}{2} \pm \sqrt{\frac{2 V_1^2 D_1}{g} + \frac{D_1^2}{4}}$$

From this formula, it is evident that the jump can take place whenever $V > \sqrt{g D_1}$, or whenever the velocity exceeds the critical value. A jump might take place, therefore, at any point along the back-water curve, CD, as the flow is always at less than the critical depth. If a curve, FGH, is plotted above the curve, CD, at the height to which a hydraulic jump would take place, with the conditions of flow existing at that point, it will be found that this line intersects the curve, AB, at G. At this point, therefore, one would expect the water surface to rise in a hydraulic jump, from the line, CD, to the tail-water curve, AB.

The heavy line on Plate XIX shows the actual water surface for Run No. 1. Because of friction and impact losses, it starts at a greater elevation than the theoretical value. In entering the flume, it does not drop as rapidly as the theoretical curve, the reason for which has been explained previously. After the entrance water surface drop is complete, the profile follows closely the theoretical line, the jump taking place substantially as indicated by the theory, and the theoretical tail-water surface curve also agrees well with the actual surface profile.

A study of the theoretical back-water curves for Run No. 1 shows the reason for the different conditions of flow in the flumes, resulting from different tail-water levels. If the tail-water was at a lower elevation than the bottom of the flume, the flow in the expanding portion would follow the line CD, and drop off at D to the tail-water below. Until the water surface rose to the elevation D, the profile in the flume would be unchanged. As the water surface rose from D to H, it would still follow the line CD, and a phenomenon resembling the hydraulic jump would take place below the end of the flume. If the tail-water level is still further increased, the condition of flow in Run No. 1 would occur, the jump being formed in the flume

* This formula is usually accredited to Unwin, but according to Mr. S. M. Woodward, it was derived by a Frenchman, Belanger, in 1838.


Coefficient
1.10
1.00
0.90
0.80
0.70
D'AUBUISSON FORMULA
WEISBACH FORMULA
1.0
2.0
3.0
4.0
5.0
Distance from Entrance, in Feet
EXPERIMENTS ON FLOW
THROUGH
EXPANDING FLUME
RUN No. 5
Elevation of Headwater
Velocity Head
Loss of Head
Water Surface
Depth, in Feet
1.4
1.2
1.0
0.8
0.6
0.4
0.2
Discharge = 3.1 Sec.-Ft.
Critical Depth
Bottom
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
Distance from Entrance, in Feet

itself. Below the jump, the surface curve would slope upward, as *BGA*, and above the jump, the profile would follow the line *CD*. The jump would occur at the point where the back-water curve connecting with the tail-water intersects the line of height of jump, *FGH*. This condition of flow occurs for all tail-water heights between *H* and *E*, the jump moving up the flume as the water level below it is increased. Runs Nos. 1 and 2 are in this class. When the tail-water level reaches *E*, the curve connecting with the tail-water follows the line *CE*, and intersects the height of jump line at *C*, the end of the prismatic section of the flume. The depth here is at the critical value, and, therefore, no jump can take place. Run No. 3 closely represents this condition. For all heights of tail-water below, and including that at *E*, the flow through the entrance and prismatic sections of the flume remains the same, being the condition of the maximum flow. That this actually occurred is shown on Fig. 18, by the comparatively constant head-water elevation of the first three runs, the slight variation being practically all due to the slight change of discharge.

As the tail-water level rises above *E*, the back-water curve connecting with the tail-water falls above the line *CE*, and does not reach the depth of maximum flow. When the condition of maximum flow exists, the head-water elevation is the minimum which will discharge the given quantity. It follows, therefore, that if the depth in the prismatic section is greater than that of maximum flow, the elevation of the head-water for the given discharge must be greater than this minimum. As the tail-water level is increased above *E*, if the discharge remains the same, the head-water, therefore, rises. This is the condition of flow in Runs Nos. 4 and 5.

The theoretical profile for Run No. 4 is shown on Plate XIX. The back-water curve in the entrance section follows Case 4, which, for a channel of decreasing width, the depth of flow being above the critical value, gives a downward slope. In the prismatic section, the profile follows Case 1, of channels of uniform width, being horizontal. In the expanding section, the flow is according to Case 1, for channels of variable width, and the water surface slopes upward. A comparison of the actual with the theoretical profile for this run shows that, except for the effect of the waves, the actual water surface profile agrees very closely with the theoretical profile.

New Water Measuring Devices.

Although the experiments described in this paper were not undertaken primarily for the purpose of developing apparatus for the measurement of flowing water, some of the devices experimented on possess considerable promise as measuring devices. This is particularly true of the sharp edge contractions and the expanding flume. While the contraction with rounded entrance might be used for water measurement, all of its advantages and none of its disadvantages are found in the sharp edge contraction. The same is true with respect to a comparison of the short flume with rounded entrance and the expanding flume, the latter possessing all the advantages of the former, and other good points in addition. The few experiments on the short flume with sharp corners do not indicate that it has any particular value for measuring water.

The requirements of the ideal measuring device for irrigation purposes have been stated by Mr. V. M. Cone,* as follows:

"The ideal measuring device would (1) be inexpensive to construct, (2) be simple to operate, (3) require little maintenance, (4) be free from working parts, (5) be accurate in its measurement, (6) be free from sand, silt, or floating-trash troubles, and (7) require but little loss of head in the ditch."

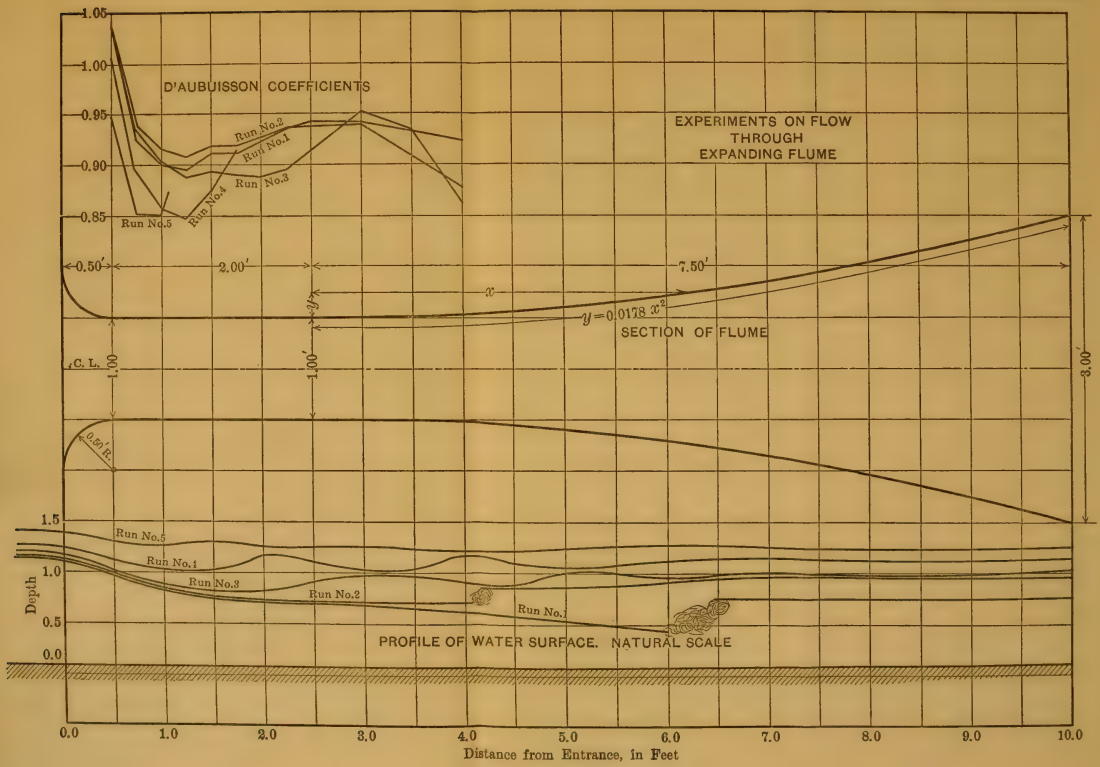
The sharp edge contraction seems to fulfill all these requirements. It combines the advantages of the sharp edge weir and submerged orifice, without the disadvantages of either. A somewhat similar device has been developed by Mr. Cone,† but it requires greater fall in the ditch, as the water surface below the "weir" must be below the bottom of the approach channel.

To adapt the expanding flume to the measurement of water, it would be necessary, in addition to a gauge box in the channel above the flume, to connect a still box into the side of the flume about 2 ft. below the upper end, in order to read the depth of water in the throat. Although in most cases it would be necessary to read only the up-stream gauge, where conditions are such that no hydraulic jump is formed it would be necessary to read both gauges. A much simpler shape of flume might be devised, using the same principle as the writer's flume, but better adapted to working conditions. A flume of this sort has

* "The Venturi Flume", *Journal of Agricultural Research*, Vol. IX, No. 4.

† "A New Irrigation Weir", *Journal of Agricultural Research*, Vol. V, No. 24.

PLATE XVIII.
PAPERS, AM. SOC. C. E.
OCT.-NOV.-DEC., 1919.
LANE ON
FLOW OF WATER THROUGH CONTRACTIONS.



been worked out independently by Mr. Cone, and described in his article on "The Venturi Flume", previously referred to. The experiments on this flume, however, covered only those stages where $D_2 > \frac{2}{3} D_1$. In limiting its use to this range, the writer believes that one of the important advantages is overlooked, namely, that the discharge at most stages is independent of the tail-water level. This feature makes the action of the expanding flume similar to that of the weir, while, at the same time, it is free from the silt troubles of a weir and requires much less loss of head. The writer very much regrets that he was prevented from carrying out a thorough test of this device, and would be glad to see it taken up by some one having the proper facilities, and developed into a practical measuring apparatus.

Conclusions.

In conclusion, the writer wishes to reiterate the common, but often neglected, warning of using formulas blindly in cases to which they do not apply, or beyond the limit of the conditions for which they were developed. This has been expressed by Mr. Woodward,* in the following words:

"Perhaps the most frequent error in hydraulic discussions, in general, is the very common one of applying a law, rule, or formula to a situation where it does not hold. Every rule in hydraulics is limited in its application to a definite set of conditions outside of which it may have no bearing whatsoever. This tendency to apply a perfectly good rule or formula to the wrong situation is naturally not only difficult to avoid in the first instance, but also not easy to refute by argument after the mistake has been made."

The number and diversity of the formulas considered in this discussion are indicative of the many conditions under which water may flow through a contraction in a channel. It is obvious that the application of any of them to all conditions, will lead to very erroneous results.

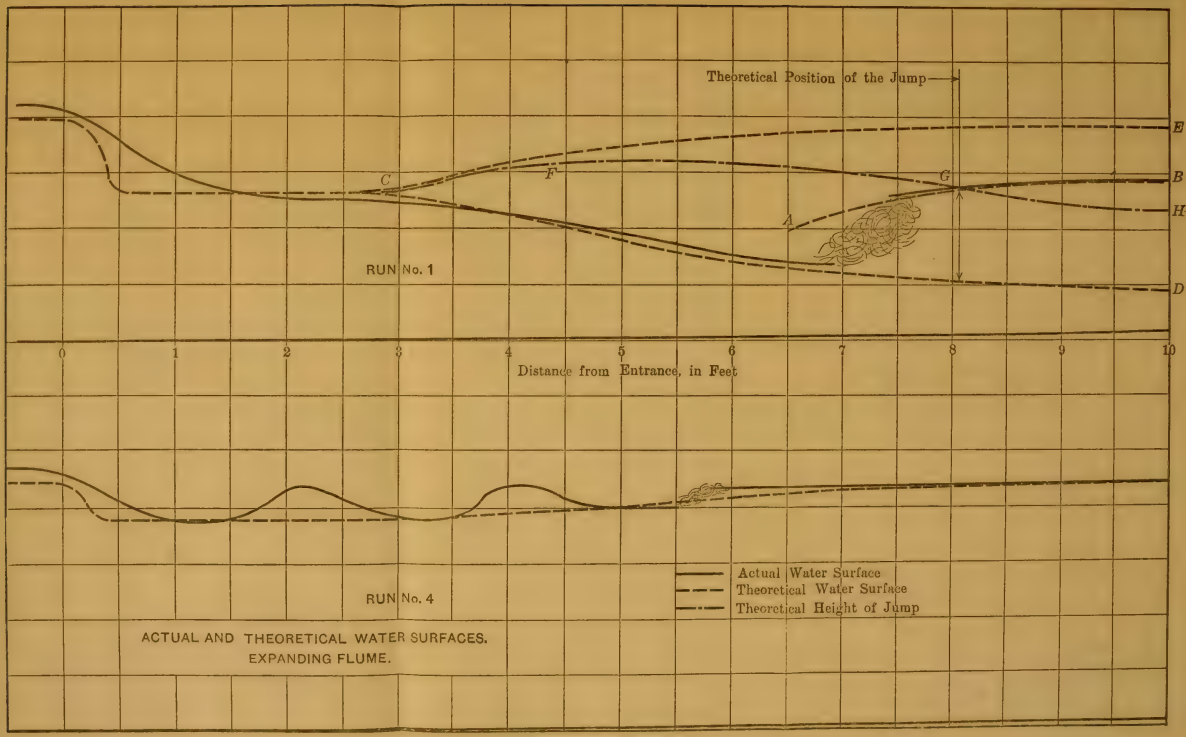
The d'Aubuisson formula is really an application of the Bernouilli theorem, with a coefficient to take care of the losses. The conditions in which it can be used are, in general, the same as those of the Bernouilli theorem. It can best be applied to contractions in which

* "Theory of the Hydraulic Jump and Back-water Curves," Miami Conservancy District, Technical Report, Part III, p. 11.

the water flows from one stage to another without a great deal of turbulence. The two areas of measurement must be the actual area of flow of the water, and the conditions at these points such that the static pressure on each particle is equal to the weight of the water above it, up to the free water surface. These conditions are fulfilled by the flow through the prismatic sections of the expanding flume and the short flume with rounded entrance, and also in the contraction with rounded entrance, where $H_3 < \frac{1}{3} D_1$. To a certain extent it can be applied to the short flume with sharp corners, the turbulence introduced by the sharp edges causing a lower value of the coefficient. It can rarely be applied where a reduction of velocity occurs, unless this reduction is gradual, as in several of the experiments on the expanding flume.

The conditions most favorable to the Weisbach theory are those existing at a sharp edge contraction of narrow width. The drop of the water surface above or in the contraction must be as small as possible, and the stream, after passing the contraction, must be free to expand laterally, since it is necessary that no pressure is exerted on those particles passing through the contraction above the tail-water level, in order that they may acquire a velocity corresponding to their distance below the head-water level. If the sharp edge contraction is wide, there will be a greater drop in the water surface above the contraction, and the formula will be less exact in its application. As the condition of flow in the case of a sharp edge contraction is very similar to that through an orifice or over a weir, the coefficients of both should be approximately the same.

On account of the surface drop which always takes place above a contraction, the condition assumed in the Weisbach theory will be only approximately attained. By modifying the Weisbach formula by giving different coefficients to that part of the flow above tail-water level, and that below it, a formula can be obtained, which will give results with a high degree of accuracy. The difference in the coefficients for these two parts is caused by the surface drop above the contraction, which reduces the flow through that portion above the tail-water level only. This formula is probably applicable to a great range of widths of the sharp edge contraction, and one may expect the coefficient, for that part of the flow below the tail-water level, to increase, while that for



ACTUAL AND THEORETICAL WATER SURFACES.
EXPANDING FLUME.

the part above the tail-water level decreases, as the width of the contraction is increased.

The general formula for contractions (Formula (19)) is adapted to contractions of short length, in which the stream is free to expand immediately after passing the narrowest point. This formula, in special cases, may take the form of either the d'Aubuisson or the Weisbach formula. The coefficients in it are substantially the same as those of an orifice of the same character of edges. This formula has the disadvantage that it contains the term, H_2, the drop of the water surface at the most contracted section, which is often difficult to measure.

Formula (12) is very similar to the general formula, but the term, H_2, of the general formula is replaced by the term, $\frac{1}{3} D_1$. For the contraction with rounded edges, where $D_3 < \frac{2}{3} D_1$, to which Formula (12) is applicable, H_2 is substantially equal to $\frac{1}{3} D_1$. For the contractions, the coefficients have been found to be a function of $\frac{H_3}{D_3}$.

The flow in the expanding flume follows very closely the theory of back-water curves. For a frictionless channel, with level bottom and variable width, the following four back-water curves are found to be possible:

Case 1.—Width increases; water surface slopes upward; depth greater than the critical value.

Case 2.—Width increases; water surface slopes downward; depth less than the critical value.

Case 3.—Width decreases; water surface slopes upward; depth less than the critical value.

Case 4.—Width decreases; water surface slopes downward; depth greater than the critical value.

A stream is flowing at the critical depth when $V = \sqrt{g D}$.

The condition of "maximum flow" has been found to exist substantially as indicated by the theory. The flow may exceed this "maximum", however, where the stream is allowed to expand at or immediately after the point at which the depth of maximum flow is reached.

The sharp edge contraction and the expanding flume are believed to possess value as measuring devices, and should be investigated further.

From Appendix II, it may be concluded that when a channel, in which water is flowing at high velocity, changes abruptly into a wider channel, with a bottom approximately level and at nearly the same elevation as that of the narrower channel, an unstable condition of flow may result.

ACKNOWLEDGMENTS.

The writer wishes to express his appreciation of the assistance of the following: To A. E. Morgan, M. Am. Soc. C. E., and C. A. Bock, Assoc. M. Am. Soc. C. E., for encouragement in undertaking these experiments; to the Morgan Engineering Company and the Miami Conservancy District for the use of instruments, without which the experiments could not have been performed; to S. M. Woodward, M. Am. Soc. C. E., Ivan E. Houk, Assoc. M. Am. Soc. C. E., and Mr. J. D. Burrage, for valuable suggestions and for assistance in preparing the manuscript; and to many of the Engineering Staff of the Miami Conservancy District, who, from time to time, assisted in the experiments.

APPENDIX I.

Application of the Theory of Flow Through Contractions to the Design of the Flood-Prevention Works of the Miami Conservancy District.

In the investigation for the design of the flood-prevention works of the Miami Conservancy District, one of the first problems encountered was that of the flow of water through a contraction in a channel. Soon after the flood had subsided, an extensive hydrographic survey was made to determine the discharge and slope of the river, and the area covered by the flood at its highest stage. It was found that a considerable drop in the water surface occurred at a number of bridges. The magnitude of the drop could be determined from the high-water marks, and the area of the stream above, and, in the narrow section, could be easily measured. If the law relating to these areas, the drop, and the discharge of the stream, were known, a convenient method of determining the flood discharge was available.

The method of computing the peak flow from these measurements has been given in detail elsewhere,* and, therefore, will not be described here. The method used was devised by Messrs. S. M. Woodward and Ivan E. Houk. Essentially, it is the d'Aubuisson theory with a correction based on a computed friction loss. As the Weisbach formula was the nearly generally used form, these experiments were originally undertaken to compare the merits of the two theories. The results of these experiments show that, for the conditions at these bridge openings, the method used was much superior to the Weisbach formula.

Another case involving a determination of the drop which takes place at a contraction, arose in connection with the design of the retarding basins which are to be used in this flood-prevention system. Five large dams are being built across the Miami River and its tributaries to form basins for the storage of flood-water. Through these dams will be conduits, through which the ordinary discharge of the river will pass, but which are not large enough to discharge the flood flow of the river. The flow in excess of the capacity of these conduits will be retained in the basin above the dam until the flood peak is

* "The Official Plan of the Miami Conservancy District," Vol. I, pp. 67-71; Technical Report of the Miami Conservancy District, "Calculation of Flow in Open Channels," Part IV.

passed, and will then be discharged through the conduits into the stream again. In several of the dams, these conduits consist of large openings through a short spillway, which is a section of ogee dam, flanked at the ends by high concrete retaining walls. In order to take care of the flow of the stream during the construction period, it is proposed to build these walls first, leaving out the ogee spillway and conduit section until the earth section of the dam is complete. In times of freshet, all the water must pass through this comparatively narrow opening, and, in times of flood, considerable heading up will take place. As these dams are above populous cities, the backing up of the water to such an extent as to overtop the partly completed fill would be disastrous. In order to estimate accurately the height to which the water would rise behind the dam during a flood, a knowledge of the true laws governing the flow of water through a contracted opening was necessary.

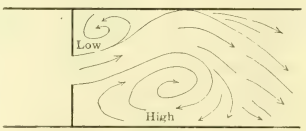
To estimate the area and frequency of the flooding of land which will take place in the future, as a result of the construction of the detention dams, computations were made to ascertain the area which would have been covered by the floods that have occurred in the past. In several of these dams, the conduits are large, and as the floor of the basin is very flat, considerable land would be flooded in the basins before the water reached the top of these openings. In many of the smaller floods, the flow would never be sufficient to reach the top of the conduits. While the basins were filling to this point, the flow would take place through the conduits in the same manner as through a bridge in which the piers occupy a large portion of the waterway. Here, again, in order to determine the backing up which would take place, an understanding of this phenomenon of flow was necessary.

APPENDIX II.

Unstable State of the Stream from the Contractions.

Whenever a channel in which water is flowing at high velocity changes abruptly into a wider channel, with a bottom approximately level, and at nearly the same elevation as that of the narrower channel, an unstable state of flow may occur. The conditions under which this took place in the experiments on the contractions are shown in Fig. 20. When the water started to flow through the contractions, it passed down the center of the channel below, with a slight eddy on either side. (Fig. 20 (*A*)). This was an unstable condition, however, and soon the stream began to waver slightly and then was deflected to the side, as shown on Fig. 20 (*B*). This was a stable state, and the flow would continue in this position indefinitely. It was quite difficult to deflect it back into a central position again. At first the writer thought that it was due to slight irregularities in the bottom, but as the deflection seemed to take place as often to one side as to the other, and as he had observed the same phenomenon in another apparatus under somewhat similar conditions, the conclusion was reached that this was not the cause.

(*A*)



(*B*)

Fig. 20.

When the stream from the contraction flowed in the center of the channel, the friction of this moving water on the quiescent water on both sides tended to draw this quiet water away from the contraction, making the tail-water level near the contraction lower than at some distance down stream. The water level on both sides of the flowing stream in this unstable state, was the same. The higher water down stream, however, tended to flow back toward the contraction, and if a slightly greater quantity flowed back on one side of the stream than on the other, the water level on that side became higher. The quiet water on this side, therefore, exerted a greater pressure on the flowing stream than the water on the opposite side, tending to force the flowing stream

toward the lower side. This allowed a larger quantity of water to flow back on the higher side, causing a still greater deflection, which increased until the position shown on Fig. 20 (*B*) was reached. The change of the flowing stream from a central position to a permanent deflection to the side of the channel was a matter of only a few seconds.

To remedy this condition, a low submerged weir was placed across the channel, 8 ft. below the bulkhead (Plate XII), which introduced a slight drop in the water surface at this point. The water surface below this weir was lower than the surface of the tail-water on the two sides of the stream, near the contraction, and there was no tendency of the water, therefore, to flow up the channel toward the contraction and cause a deflection of the stream.

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PAPERS AND DISCUSSIONS

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THE PRODUCTION OF TOLUOL FROM GAS PLANTS*

By Myron S. Falk,† M. Am. Soc. C. E.

Synopsis.

Toluol is the hydro-carbon which forms the base of the well-known explosive, T.N.T. In 1914, the production of toluol in the United States was estimated at 700 000 gal. for the year; during the war the United States Ordnance Department undertook measures to increase the production and, at the time of the signing of the armistice, it was conservatively estimated that, at the end of 1919, such production would have been at a rate of at least 32 000 000 gal. per year. This increase was obtained:

(*a*) By stripping gas manufactured in water gas plants;
(*b*) By building coke oven plants;
(*c*) By cracking petroleum oils and solvent naphtha; and
(*d*) In various other ways yielding small quantities.

The development, with regard to stripping water gas, furnished interesting problems in connection with the standards of illuminating gas established by Public Service Commissions throughout the country and, for this reason, became involved in the National problem of the conservation of fuel. In New York City, the situation was further

* This paper will not be presented for discussion at any meeting of the Society, but written communications on the subject are invited for subsequent publication in *Proceedings*, and with the paper in *Transactions*.

† New York City.

complicated by State legislation which regulated not only the price of gas, but its quality.

This paper traces these complications, and brings forward for consideration the question, whether or not an enormous waste in fuel is still taking place, because of heat or light standards established when it was comparatively cheap.

The standard United States Army high explosive at the beginning of the war was Trinitrotoluol, more generally known as T.N.T., which is obtained by nitrating toluol, a colorless, oily liquid. Chemically, toluol is a hydrocarbon of definite composition, having the formula, $C_6H_5CH_3$, of the so-called benzene series. The specifications of the United States Ordnance Department require that its paraffin content shall not be more than 3% of the volume, and that it shall all distil between 109.4° and 111.4° cent. About 15 lb. of crude T.N.T., or 13½ lb. of refined T.N.T., can be produced from 1 gal. of toluol.

Prior to August, 1914, toluol was made in the United States to a limited extent, the production in that year being estimated at about 700 000 gal. It was used in chemical trades, as, for example, in the rubber industry and in the manufacture of saccharin, drugs, and dyes, but, for the most part, it was not separated from other oils with which it was manufactured. At that time, the principal source of toluol was from the by-product coke ovens, where it was obtained from the distillation of coal, in specially designed condensing apparatus; small quantities were also obtained from some of the gas companies from their gas-holders and drips.

Shortly after the beginning of the war, in 1914, both the British and French Governments desired great quantities of T.N.T., and, in consequence, many toluol and T.N.T. plants were placed under construction in the United States. By the spring of 1916, the capacity of the T.N.T. plants in this country had reached an output of about 5 000 000 lb. per month, and plants of less capacity were operating in Canada. Practically all the toluol needed for these plants was produced in the United States, and, in addition, some excess was produced and exported for nitration to British and French factories.

The urgent demand for toluol resulted in forcing its price to $7.00 per gal., in the spring of 1915. The price fluctuated between that and $4.00 per gal., until the spring of 1917, although trade journals have

recorded sales as high as $12.00 per gal. In April, 1917, the market price was $4.50 per gal.

It was apparent in May, 1917, when the requirements of the Ordnance Departments of the Army and Navy took definite shape, that there would be a most serious shortage in toluol. In June, a conference between these Departments, as well as representatives of England, France, Italy, and Russia, was held, and in July, 1917, the Council of National Defense appointed a board to investigate this situation. This Committee reported on July 27th, 1917, that the existing plants would not be able to meet the demand. A Sub-Committee on Coal Tar By-Products was formed and instructed to report as to methods to be followed to relieve the situation, and it was not until September 17th, 1917, that its report, with recommendations, appeared.

It is apparent, consequently, that, at the beginning of the war, the United States was not prepared to meet the situation with regard to its most important high explosive. Fortunately, the requirements of T.N.T. were considerably decreased in the fall of 1917 by the adoption by the Ordnance Department of amatol as the standard shell-filler for explosive shells. Amatol is a mixture of T.N.T. and Ammonium Nitrate, in proportions varying from 20% of T.N.T. and 80% of Ammonium Nitrate, to 50% of either, these mixtures being used at that time by the Allies as one of their standard high explosives.

The Gun Division of the Ordnance Department was charged with the responsibility of relieving the situation with regard to toluol, and Col. Jay E. Hoffer, then in charge, assisted by Col. (then Maj.) James H. Burns, requested permission from the War Industries Board, in September, 1917, to contract with gas companies for the construction and operation of toluol-recovery apparatus. There was formed, therefore, within the Gun Division, the Toluol Branch of the Explosives Section, which took complete charge of the constructive development of the toluol industry. Steps were taken immediately to investigate every possible source from which toluol could be derived, but, inasmuch as a definite recommendation had already been made to build apparatus in the works of gas companies to strip domestic gas of its light oil content, the first measures adopted were to negotiate contracts for the construction of such apparatus and to obtain the consent of the various gas companies and Public Service Commissions interested, so that this work could proceed.

These negotiations were most difficult, because stripping the gas decreased its candle-power. The question of the candle-power furnished by the gas companies to consumers had been for years a most delicate one, and, therefore, representations had first to be made to the Public Service Commissions requesting that the standard of candle-power be reduced. Amicable negotiations were concluded between the Ordnance Department and the Public Service Commissions in all cities in which it was desired to make such installations, except in the case of New York City, where the Public Service Commission laid down rules impossible for the gas company or the Ordnance Department to accept. The urgency of the situation in the case of New York City required drastic action, inasmuch as this city was expected to furnish a very large portion of the toluol. With the acquiescence of the gas companies, it was determined, therefore, to proceed immediately to construct within the plants of the Consolidated Gas Company and the Brooklyn Union Gas Company thirteen stripping plants for the extraction of toluol, the Ordnance Department guaranteeing, for its part, to hold harmless the gas companies from any damages whatever caused either by the construction or operation of such plants, and the gas companies, on their part, agreeing to furnish the land free of charge and to operate the plants at absolute net cost, without any profit whatever.

Altogether, thirty-two gas-stripping plants were placed under construction in all parts of the country, from Boston, Mass., to Albany, N. Y., to Washington, D. C., to New Orleans, La., St. Louis, Mo., Denver, Colo., and Seattle, Wash., and contracts for the construction of all these plants were let as promptly as possible to three contractors, the work being divided between them as the judgment of the Toluol Branch deemed best under the circumstances.

It should not be thought, however, that the choice of location of these various plants was left to any haphazard guess. The Toluol Branch was very careful prior to awarding any contract to make tests of the gas that was being manufactured, to determine the suitability of its toluol content for nitration. Estimates of cost of construction and operation were gone into most carefully, the general rule laid down having been that no plant should be undertaken which would cost for construction more than the product obtained by multiplying its estimated yearly output, in gallons, by $2.00, and unless it could be operated at an expense not to exceed $1.50 per gal. of output.

Provision had also to be made for refining the crude toluol which was to be obtained from these gas plants, and for transporting both the crude and pure toluol, 250 tank cars having been ordered and purchased for this purpose alone. In addition, arrangements had to be made for the chemical control of the plants, to devise test methods for operation, and to instruct and drill the operators.

The gas which was stripped by the Ordnance Department, was usually carbureted water gas, manufactured by adding gas-oil vapors to a blue gas formed by the chemical interaction between steam and incandescent coke or hard coal. As a rule, from 3 to 4½ gal. of oil were added to each 1 000 cu. ft. of gas manufactured, the quantity of oil used being dependent on the illuminating quality and heat units required in the gas as finally sent out. In New York City, for example, the State laws required the standard for gas to be 22 c-p., and, for this purpose, generally, 4½ gal. of gas oil were required for each 1 000 ft. of gas. This gas contained approximately 650 B.t.u., or more, per cu. ft., and the gas-stripping apparatus through which it passed recovered as toluol about 2% of the gas oil used in the manufacture of the gas. In addition, however, to the toluol recovered, a considerable quantity of benzol and solvent naphtha was also recovered, the quantity of benzol being about one and one-half times that of the toluol and the quantity of solvent naphtha about one-half that of the toluol. These other by-products were also valuable for explosives, inasmuch as benzol was used as the base for picric acid, the favorite high explosive of the French, and solvent naphtha was in demand by the Navy for one of its high explosives—tri-nitro-xylol—although the manufacture of the latter by the Navy never reached quantity production. Large quantities of picric acid, however, were made in the United States for the French, particularly as a replacement to them of explosives loaned to this Government.

Toluol Recovery.

The gas, as manufactured by the gas companies, is passed through a tall tower filled with wooden grids through which an absorbent oil is circulated. The gas passes counter-current to this absorbent oil and loses its toluol, benzol, and xylol content, and is then distributed through the mains of the gas company to the consumers, without these light oils. The quantity of these light oils which can be absorbed, is

dependent both on the quantity of absorbent oil circulated through this tower, on its absorbing quality, and on the temperature and the velocity of the passing gases, so that wide variations of stripping can be obtained by manipulation. Later, the light oils are separated from the absorbent oil by the customary distillation processes using steam.

The gas which is then distributed through the mains, has lost a considerable portion of its candle-power, as well as some of its heat content. It is possible in some cases to add enough gas oil in the original manufacture of the gas so that, even after scrubbing, the gas will have the desired candle-power, but this method of retaining candle-power is most extravagant and wasteful, since oil is the most expensive ingredient used in the manufacture of gas; or, the gas may have its former lighting power restored by spraying back into the scrubbed gas other light oils, exclusive of toluol, but this, naturally, is also most extravagant, because these light oils have a distinct commercial value.

New York City.—In New York City, the Public Service Commission had made an official order insisting either that the full statutory 22 c-p. be furnished to the consumer, or that the gas company, not exceeding the period of the war, deliver gas containing 650 B.t.u. per cu. ft., with rebates whenever the gas dropped below this standard, and requiring, further, in the latter case, that each consumer using flat flame burners, on application, would be furnished with two incandescent mantle burners, and requiring, further, that the gas companies maintain a number of testing stations.

The gas companies refused to accept this permissive order of the Public Service Commission, and matters with regard to the operation of these plants made no progress, although their construction was actively pushed, and the 21st Street Plant of the Consolidated Gas Company, one of the largest of its plants, was ready for operation on April 14th, 1918.

Officials of the Ordnance Department had held frequent conferences with the Public Service Commission, but the Commission still held its ground that the consumers of New York City must be furnished either with gas of 22 c.-p., or with gas fulfilling all the requirements of its order, and that, if necessary, either the Government would have to furnish additional gas oil to the companies, if the standard could be maintained by that method, or measures of operation would have to be adopted which would meet the order.

At this point there arose a further complication; the winter had been most severe, and the movement of all fuel supplies was extremely slow. It may even be remembered that the Fuel Administration during this time had ordered fuelless days, and it was absolutely out of the question to obtain for the gas companies more oil than they were using at that time. It was most difficult for them to obtain any oil at all, inasmuch as cargoes of it were frequently commandeered by the Army and Navy for direct military operations.

At a final conference held early in April, this situation was again explained by the Ordnance Department to the Public Service Commission, and the crying need for toluol was made clear. Under these circumstances, the Public Service Commission finally consented to permit the Ordnance Department to operate these gas-stripping plants as it deemed proper under the circumstances, it being suggested at that time that the gas to be sent to consumers should not fall below 18 c-p. and that careful records would be kept as to the complaints by consumers and as to additional quantities to be used by them.

By order of the Ordnance Department, the 21st Street Plant, therefore, was placed in operation on April 14th, 1918, followed in due course by the other plants. It was found that the consumers did not notice the difference in the quality of the gas, and experiments were carried out, therefore, at the Mutual Gas Company's plant, to determine whether further lowering would cause any complaints. The candle-power was dropped gradually at this plant from 18 c-p. to as low as 10 c-p., and yet no additional complaints were received from the consumers. When this situation was further explained to the Public Service Commission, the Commission acquiesced in permitting the representatives of the Ordnance Department to operate these plants at a standard lower than the 18 c-p. originally set, and, in consequence, a gradual decrease in candle-power output was effected at all plants until, at the time of the signing of the armistice, the average candle-power in New York City was approximately 16, and yet the consumers were apparently ignorant of the fact.

Careful records were also kept as to the loss in heat units resulting from the stripping of the gas, and it was curious that no exact ratio could be found between loss of candle-power and loss of heat units. It is probable that the average heat units in a cubic foot of gas which

averages 16 c-p., were probably in the neighborhood of 620 B.t.u.; in other words, the gas lost 27% of its illuminating power and less than 5% of its heating power.

Mention has been made of the serious shortage in the supply of oil during the spring and summer of 1918. The distribution of oil throughout the United States had been placed in the hands of the Fuel Administration, and one of its assistants conceived the idea that a tremendous quantity of oil could be saved for the country's commercial industries for war purposes if the gas companies throughout the country were prohibited from using their usual supply of gas oil. The Fuel Administration had taken a census of the total quantity of oil used by the gas companies for this purpose, and had estimated that the average heating value of the gas produced throughout the United States was about 600 B.t.u. per cu. ft. of gas, and that if a compulsory order were issued by the National Government ordering that no gas be furnished to consumers higher than 528 B.t.u. per cu. ft., that a possible saving would be made of about 0.7 gal. of oil per 1 000 cu. ft. of gas. This proposed action of the Fuel Administration was of the greatest importance to the Toluol Branch, which at that time had practically completed plants estimated to produce 5 000 000 gal. of toluol per year, and as the production of toluol was directly dependent on the quantity of gas used, this order would have resulted in a loss of production of 1 500 000 gal. of toluol per year from the Ordnance plants alone, and a loss of about 750 000 gal. from plants owned by private interests. The Ordnance Department, however, studied the problem, and obtained figures to show that the large savings in oil by such a reduction in standard were not as great as the Fuel Administrator believed, and efforts were made to impress the importance of non-interference with the production of toluol.

On April 23d, 1918, the Fuel Administration was preparing to issue an order forcing the gas companies to cut down their consumption of oil to 2¾ gal. per 1 000 cu. ft. of gas manufactured. It should be noted that this action of the Fuel Administration would naturally have the backing of all gas companies using gas oil in manufacture, as it would enable them to reduce their operating costs by a material amount and would possibly give them renewed hearings before Public Service Commissions for a re-opening of rate cases, which many of the companies,

because of increased costs, were then endeavoring to obtain. The Ordnance Department persuaded the Fuel Administrator not to issue this order (see Appendix 1) without giving all the departments interested a chance to appear, and, on May 18th, 1918, a conference was held at the office of the National Committee on Gas and Electric Service. Many reports and statistics had been prepared by the gas industry to support the order of the Fuel Administration; in general, all gas company officials testified that the consumer received the same benefit from gas of low heating value as from gas of high heating value, while representatives of the Public Service Commissions and of the Bureau of Standards testified to the contrary. The Ordnance Department at no time took sides in the dispute as to the merits of this phase, as it recognized that such matters were not within its jurisdiction, but always based its arguments against issuing the order, because of its effect on the toluol programme, on two distinct reasons: (*a*), that the quantity of oil saved would not be great, inasmuch as the majority of gas plants would still require the same quantity of oil in order to produce toluol; and (*b*), in that case, the oil required in excess of that needed to furnish 528 B.t.u. gas, would have to be furnished to the gas companies by the Ordnance Department at an expense to it of many millions of dollars.

The Toluol Branch prepared statistics (Table 1) showing the production of toluol from gas plants, assuming the standards to remain unchanged and then to be established at 575, 550, and 528 B.t.u. per cu. ft. of gas, and also statistics (Table 2) showing the total quantity of gas oil used in the New England, Middle Atlantic, Middle West, Southern, and Pacific States, both in plants producing toluol and those not producing toluol.

On June 5th, 1918, a conference was held at the office of the Fuel Administration, at which representatives of the various State Public Service Commissions presented their views. On the following day, the Oil Administrator, and representatives of the Ordnance Department, discussed all the statistics that had been prepared, and, as a result of this conference, the Oil Administrator stated that he was convinced that the quantity of gas oil saved by issuing an order for a lower standard for gas would not warrant the order.

Consequently, the Ordnance Department considered the matter closed, but, apparently, interests connected with the gas industry were

TABLE 1.

Production of Toluol from gas plants, in gallons.		Reduction in production, in gallons.
With existing standards	9 400 000	.....
" 575 B. t. u. "	8 450 000	950 000
" 550 " " " "	8 000 000	1 400 000
" 528 " " " "	7 500 000	1 900 000

TABLE 2.

	Gas Oil Used, in Gallons:		Total, in gallons.
	In Toluol Plants.	In Non-Toluol Plants.	
New England States	48 750 000	18 000 000	66 750 000
Middle Atlantic "	426 902 000	156 000 000	583 702 000
Middle West "	164 053 000	60 600 000	224 653 000
Southern "	9 700 000	3 580 000	13 280 000
Pacific "	2 600 000	961 000	3 561 000
	652 005 000	239 941 000	891 946 000

Note.—Oil-gas process plants on the Pacific Coast are not included.

not satisfied. The Fuel Administration announced, about the end of June, that a Director of Gas Plants had been appointed, and the question of lowering the standard was immediately re-opened. On July 22d, 1918, the Director of Gas Plants called a meeting at his office, at which there were present representatives of the Fuel Administration, the Bureau of Standards, the War Trade Board, the National Committee on Gas and Electric Service, and the Ordnance Department. The Director of Gas Plants was very frank in announcing that it was his intention to have the Fuel Administration issue a notice ordering the standard of all artificial gas to be 528 B.t.u. per cu. ft. The Ordnance Department immediately took exception to the order as prepared (see Appendix II), basing its opposition on two broad claims: First, that the order as issued would save very little oil, and, second, that it would transfer millions of dollars from the Treasury of the United States to the gas companies. Because of these objections, the Director postponed issuing this order, and a further conference was called for August 28th, 1918, at which representatives of the gas companies, the Public Service Commissions, the Fuel Administration, the Bureau of Standards, War Industries Board, War Trade Board,

and Ordnance Department, were present. At this meeting only representatives of the gas companies were heard, and they were almost unanimous in stating that, in their opinion, the consumers would not feel the reduction in heat or light standards and that it was for the best interests of the country to reduce these standards. It seemed to the representatives of the Ordnance Department that the Director of Gas Plants had definitely determined to issue the order, and the matter was deemed so urgent that the Ordnance Department presented its case through the Chief of Ordnance to the Secretary of War.

In consequence, on September 7th, 1918, the Assistant Secretary of War addressed a letter (see Appendix III) to the Fuel Administrator citing the history of the case and requesting that the so-called 528 B.t.u. order be not issued. On receipt of this letter, the Fuel Administrator appointed a new committee consisting of the Director of Gas Plants, the Director of Natural Gas Plants, and a representative of the Bureau of Standards, to report as to the advisability of issuing this order. This Committee presented a divided report, the representative of the Bureau of Standards recommending that the order be not issued. The Committee finally agreed, however, as a compromise, that in place of issuing a mandatory order to the various gas companies throughout the country, a request (see Appendix IV) be made by the Fuel Administrator to local authorities throughout the country that they arrange with their service corporations to maintain as low a standard as could be considered consistent with efficient and good service, the object being to conserve the maximum quantity of fuel for more necessary purposes. The form of this request was satisfactory to the Ordnance Department, inasmuch as it left open to that Department a chance for appeal to local authorities should it be found that the toluol programme would be affected adversely.

The signing of the armistice, on November 11th, 1918, changed conditions again, and, shortly after that time, Dr. Harry A. Garfield issued the following notice to the press:

"U. S. Fuel Administration.

"Washington, D. C.

"B. T. U. Standard Not To Be Changed.

"United States Fuel Administrator, Harry A. Garfield, announced to-day that, under existing conditions, he did not feel warranted in

recommending to local boards the abandonment of existing gas standards as a fuel-saving measure.

"A special committee was appointed in connection with the Bureau of Standards to investigate the heat value of artificial gas, but since the creation of this committee, Mr. Garfield pointed out, the fuel situation has materially changed.

"Public Service corporations are asked to consider whether a reduction of British Thermal Unit Standards by companies under their jurisdiction, will actually save oil, with the recommendation that if a reduction in quality is ordered, there should be simultaneously a corresponding reduction in the price of gas. The statement says:

"'In July last the United States Fuel Administrator appointed a special committee in conjunction with the Bureau of Standards, to investigate the heat value of artificial gas with a view to recommending what change, if any, in the B.t.u. standard would save coal or oil. Since the creation of this committee, the fuel situation has materially changed. The production of bituminous coal has increased under the stimulus of the Administration to unheard of figures, and the situation is not as critical as last summer. Yet, it is probable that under zoning orders of the Fuel Administration, some gas plants throughout the country will not be able to receive their customary rate of coal, and this may necessitate a temporary reduction in gas standards.

"'At the cessation of hostilities the demand for oil and coal will be transferred to other channels and the pressing demand for immediate deliveries will be reduced to such an extent that the Fuel Administrator does not feel warranted in asking local boards to abandon existing standards.

"'While it is not within the province of the Fuel Administration to request thrift in general, Mr. Garfield desires to call attention to the fact that we are using our oil deposits perilously fast, and therefore Public Service Commissions should consider whether or not a reduction of B.t.u. standards by the companies under their jurisdiction will actually save oil. In the interest of the public, however, wherever a reduction in quality is ordered or approved, there should be simultaneously made a corresponding reduction in the price of gas.'"

Finally, it is most interesting to point out what the Ordnance Department did accomplish between May, 1917, and October, 1918. Table 3 shows that the production was more than doubled in that period; and it also shows to whom the supply was distributed. It should be remembered, however, that the work of increasing the supply was still under way at the time of the signing of the armistice; grant-

ing no unforeseen contingencies, the production would have reached 2 861 000 gal. per month by the middle of 1919.

TABLE 3.

Quantity in gallons.	Source.		Quantity in gallons.	
In May, 1917:				
690 000	Coke ovens	of which	200 000	was taken by Allies as raw toluol.
75 000	Private gas plants		230 000	" " " " , nitrated.
.....	Ordnance plants		330 000	" " " Navy.
35 000	Miscellaneous		40 000	" " " Chemical Industry.
800 000			800 000	
In October, 1918:				
1 036 000	Coke ovens	of which	270 000	was taken by Allies, nitrated.
270 000	Private gas plants		100 000	" " " Navy.
337 000	Ordnance plants		82 000	" " " Chemical Industry.
54 000	Miscellaneous		925 000	" " " Army, nitrated.
			320 000	" surplus for Army.
1 697 000			1 697 000	

APPENDIX I.

"United States Fuel Administration
"Oil Division

"Washington, D. C., May 17th, 1918.

"Order.

"M. L. Requa, *Director.*

"It appearing to the United States Fuel Administrator that it is essential to the National security and defense, and the successful prosecution of the war, that the greatest possible use be made of our supplies of petroleum,

"The United States Fuel Administration, acting under authority of an Executive Order of the President of the United States, dated 23 August, 1917, appointing said Administrator, and of subsequent Executive Orders, and, in furtherance of the purpose of said Order and of the Act of Congress therein referred to and approved August 10, 1917.

"Hereby orders and directs that until further or other order of the United States Fuel Administrator,

"The standard for artificial gas as manufactured for distribution, is hereby fixed at 528 British Thermal Units per cubic foot (Massachusetts standard), superseding all previous standards.

"The above order is to take effect immediately and to become operative with the least possible delay.

"Nevertheless, it is expressly understood that all gas companies, with toluol plants, shall use sufficient oil and shall conduct their operations in accordance with the requirements of the Ordnance Department, so as to obtain the maximum amount of toluol which their plants can produce; but the B.t.u.'s in the distributed gas, must not be reduced below the standard (of 528) fixed herein, without special license from the Ordnance Department.

"United States Fuel Administrator."

APPENDIX II.

Proposed Order by James T. Lynn, Director of Gas Plants, July 22d, 1918.

"Order.

"1. It appearing to the United States Fuel Administrator that it is essential to the National Security and Defense, and the successful prosecution of the war, that the greatest possible use be made of our supplies of petroleum and coal.

"2. The United States Fuel Administrator, acting under authority of an Executive Order of the President of the United States, dated

23 of August, 1917, appointing said Administrator, and of subsequent Executive Orders, and in furtherance of the purpose of said Order and of the Act of Congress therein referred to and approved August 10, 1917.

"3. Hereby orders and directs until further or other orders of the United States Fuel Administrator:

"4. That in all plants in which artificial gas is produced for public consumption, and in which toluol or toluol-producing material is not recovered for the United States Government, or its contractors or agents, the use of gas oils and bituminous coal is hereby restricted to that amount necessary in each of said plants to produce gas having a gross heating value of five hundred and twenty-eight (528) British Thermal Units per cubic foot delivered to the consumer as hereinafter specified.

"5. That in artificial gas producing plants which now, or at any time hereafter, while this order is in force, recover toluol or toluol producing material for the United States Government, its contractors or agents, the use of gas oil is hereby permitted in excess of the amount specified in Clause 4 of this order, for the purpose of recovering such amounts of toluol or toluol-producing material, as is or shall be required in each case by the United States Government, its contractors or agents.

"6. That all illuminating-power standards of quality for artificial gas supplied for public consumption now in effect are hereby suspended.

"7. That heating value standards of quality in excess of five hundred and twenty-eight (528) British Thermal Units per cubic foot for artificial gas supplied for public consumption, are hereby suspended.

"8. That the requirement of heating value herein made shall be deemed to be fulfilled if the gas tested at any point within a radius of one mile from the manufacturing plant, shall have an average gross heating value of not less than five hundred and twenty-eight (528) British Thermal Units per cubic foot as determined from the monthly average of daily tests, and if the gross heating value of the gas so tested, in excess of this amount, shall be kept to a minimum as closely as the condition in each case shall permit.

"9. That this order shall be in effect on the fifteenth day of August, 1918, or within a period of thirty days thereafter, if the conditions in any artificial gas plant or the territory served by it require this time before the order goes into effect, but in no case shall the non-observance of this order be permitted beyond the 30-day period herein provided except by special permission of the Fuel Administrator.

"United States Fuel Administrator."

APPENDIX III.

"SEPTEMBER 7, 1918.

"MY DEAR MR. GARFIELD:

"1. It is understood that the Fuel Administration is considering the issue of an order establishing throughout the country a fixed standard for artificial gas of 528 B.t.u. per cubic foot, as a measure of conserving oil and coal.

"2. I desire to bring to your attention the effect which such an order will have upon the production of toluol from gas scrubbing plants.

"3. As one means of meeting the serious shortage in the supply of toluol required for the Army Programme, special efforts have been made to recover the maximum amount of toluol from water gas plants. The Ordnance Department is spending over $7 000 000 for additional plant facilities of this character, and from the gas scrubbing plants so provided, plus those installed by private corporations, it is estimated that toluol will be recovered from 65% of the water gas produced in the country. The yield which the Ordnance Department has been counting on is predicated on the continuance of the present heat standards.

"4. If a 528 B.t.u. order goes into effect, it seems reasonable to assume that in order to maintain the required toluol production, the Ordnance Department will have to make arrangements to supply the oil at the gas stripping plants corresponding to the difference between the requirements to maintain the present standards and the proposed standard of 528 B.t.u.

"5. To this extent, it is believed that there will be no conservation of gas oil and the Ordnance Department estimates that they will be put to an extra and unexpected expense at a yearly rate of over $4 000 000 as applied to the gas stripping plants of Greater New York only, which figure may be increased to over $9 000 000 as applied to the whole country.

"6. If the above procedure is not followed, the loss of toluol production is estimated at 2 600 000 gal. per annum, which is sufficient for about 37 000 000 lb. of T.N.T.

"7. While it is extremely difficult to estimate the probable net conservation of gas oil which would result from the establishment of a 528 B.t.u. standard, it has been estimated that this figure for the entire country would probably not exceed 1 300 000 bbl. per annum as applied to the gas plants (including the Pacific Coast) not equipped to recover toluol.

"8. While it is understood that the continued use of gas oil at the stripping plants at the rate necessary to insure the full protection

of toluol expected, would not be prevented by the proposed order, the matter is so serious in its effect economically and otherwise on the Army Programme, that I have felt the problem should be presented to you in this way, realizing that it will receive careful consideration prior to final decision in regard to the issuance of such an order.

"Respectfully,

"(Sgd.) BENEDICT CROWELL,
"Acting Secretary of War."

APPENDIX IV.

"PROPOSED FORM OF REQUEST TO LOCAL AUTHORITIES REGARDING STANDARDS FOR HEATING VALUE OF GAS, BY THE FUEL ADMINISTRATOR.

"The United States Fuel Administration is undertaking to provide in every possible way for the conservation of fuel in order to minimize the shortage which is imminent under present war conditions and needs.

"The gas companies of the country are large users of oil, coal, and coke for making gas. After several months of investigation, it has been determined that a substantial reduction in the heating value of manufactured gas and the elimination of all illuminating power standards would, in many cases, result in a material saving of these fuels.

"In consequence of this the Fuel Administration has been contemplating the issuance of an order to all manufacturing gas companies in the country to reduce the heating value of gas delivered to consumers to 528 B.t.u. monthly average. Realizing, however, that such a reduction in the heating value of gas will, in some cases, reduce the cost of manufacture and also the quantity of service rendered and thus raise questions for local authorities to adjust, the Fuel Administration wishes to accomplish these desirable changes through the voluntary action of State Commissions or local authorities, rather than directly by its own order.

"You are, therefore, advised that it is the earnest wish of the United States Fuel Administration, as a measure essential to the national security and defense and the successful prosecution of the war, that you should, wherever conditions permit of the saving of fuel in this way, take such action as may be necessary to put into effect at the earliest possible date, not later than , a reduced war-time standard for manufactured gas as distributed to consumers, considering for this purpose a minimum of 528 B.t.u.

"The reason for suggesting 528 B.t.u. is that it is the lowest

that has thus far been tried out in practice in the United States. It is the minimum which has been in effect in Massachusetts since January 1st, 1918, and which has recently been adopted by the Connecticut Commission.

"It is the wish of the Fuel Administration that the gas companies should maintain as low a standard as is consistent with efficiency and good service, in order to conserve the maximum amount of fuel. Unless such a standard is put into general effect, there may not be enough fuel to supply the needs of gas companies generally throughout the country, and a large proportion, if not all of such companies, might have to be restricted in the use of fuel to an extent which would prevent them from maintaining existing standards.

"It is particularly requested that the regulatory bodies take such steps as will put this order into immediate effect, even in cases for which readjustments of the price for gas might appear proper to local authorities.

"Your compliance with these recommendations will be in the national interest and of great assistance and relief to the Fuel Administration and make the difficult task of rationing the fuel supply of gas companies unnecessary.

"The United States Fuel Administration does not wish under any circumstances, to restrict the fuel which toluol recovering gas companies require for the manufacture of gas and the recovery of toluol to the same extent as heretofore. Gas companies recovering toluol should, therefore, be permitted to operate in excess of this standard to whatever extent is necessary to produce toluol.

"Wherever the standards for gas quality are such as to restrict or prevent the satisfactory recovery of toluol, it is urged that they be modified when so requested by the War Department. Otherwise, this request as to a change of standard does not apply to any company producing toluol.

"As a further measure of conservation, the United States Fuel Administration urges local authorities to make every effort to obtain greater efficiency and economy in the domestic and industrial uses of gas. To secure a substantial improvement in efficiency and economy in the domestic and industrial uses of gas, it will be necessary to have the users of gas exercise care and intelligence in the choice of utensils and in the burning of gas. A large part of the gas made is used in cooking and frequently the net efficiency of such operations is not over twenty-five per cent.; by care it may be considerably increased. Gas companies can help the Administration by adjusting appliances properly and teaching their customers how to use gas economically. In the industries, also, care should be taken to use

gas but not to waste it. The use of mantle lights in place of open flame burners is to be encouraged, and pilot lamps should not be burned higher than necessary.

"The Fuel Administration will appreciate reply from the local authorities as to the action which is taken or contemplated on this request".

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PAPERS AND DISCUSSIONS

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VERIFICATION OF THE BAZIN WEIR FORMULA BY HYDRO-CHEMICAL GAUGINGS

Discussion*

BY FLOYD A. NAGLER, ASSOC. M. AM. SOC. C. E.†

Mr. Nagler.

FLOYD A. NAGLER,‡ ASSOC. M. AM. SOC. C. E. (by letter).§—The writer had not intended to enter into a discussion comparing the results of all weir experiments with his own hydro-chemical gaugings. Engineering literature has worn this subject practically threadbare. In verifying the Bazin results, the hydro-chemical gaugings naturally differed from the conclusions of other experimenters; but the main intent of the paper was to offer a new set of experiments which, having been executed, was found to check with the formula for discharge of weirs, which Bazin deduced from his studies, far beyond the actual range in head of the Bazin experiments.

With the contribution to engineering practice of such valuable work as that performed by B. F. Groat, M. Am. Soc. C. E.

The hydro-chemical method of measuring water becomes quite as reliable as any so-called "tank" or volumetric process when conducted with an equal degree of skill and care. In fact, the hydro-chemical method is a volumetric process and depends on the accurate measurement of quantities of solution; and the chemist can determine the number of parts of chlorine or other element in a given quantity of water with as great refinement and ease as the engineer can measure a base line. This hydro-chemical method, therefore, becomes compatible with any other volumetric process for measuring water in an effort to determine

* Discussion of the paper by Floyd A. Nagler, Assoc. M. Am. Soc. C. E., continued from November, 1918, *Proceedings*.

† Author's closure.

‡ Albany, N. Y.

§ Received by the Secretary, November 10th, 1919.

¶ *Transactions*, Vol. LXXX, p. 951.

Mr. Nagler.

weir coefficients or check weir formulas. In neither case can exact values be obtained, but the truth is revealed in proportion to the accuracy, range, and square root of the number of measurements; and, thus, a sufficiently great number of experiments constitute an adequate basis for the "verification of any formula," or even the evolution of the formula itself.

The writer has mentioned that the experiments of the late J. B. Francis, Past-President, Am. Soc. C. E., were contained between the limits of 0.736 to 1.006-ft. head on the weir; he should have added that only the experiments on weirs with end contractions suppressed were referred to, being included in the series numbered 44-55 and 67-71, with a weir 9.992 ft. long. The writer did not attempt to make his work comparable with any experiments on contracted weirs. The mean depth of the channel behind this suppressed weir used by Mr. Francis was 5.048 ft. The pipes communicating with the hook-gauge chamber opened near the bottom of the channel, 6 ft. from the weir.* Mr. Stearns states† that the writer's point of measurement for his Gauge 2 was not comparable with that used by Mr. Francis, although it was 6 ft. from the weir, because it was not about 4.80 ft. below the weir crest. However, since the writer's weir crest was only 3.72 ft. above the bottom of the channel of approach, he believed that he was fulfilling the conditions of the Francis weir by locating the point of measurement 6 ft. from the weir and near the bottom of the channel. Incidentally, Mr. Francis‡ found the difference in the head measured 6 ft. and 12 ft., respectively, from the weir to be "inconsiderable," and on an average equal to only 0.0014 ft. for heads on the weir very nearly equal to 1 ft.

The accuracy of the statement that Gauge 1 in the writer's experiments measured the head on the weir at a point comparable with that used by Messrs. Fteley and Stearns has also been questioned by Mr. Stearns. The point used by the writer was 6 ft. from the weir and 0.414 ft. below the weir crest, and, quoting from the paper by Messrs. Fteley and Stearns on "Description of Some Experiments on the Flow of Water Made During the Construction of Works for Conveying the Water of Sudbury River to Boston,"§ we find that these experimenters used a point quite similar:

"The orifice in the glass was 0.04 ft. in diameter, and was originally 6 ft. from and 0.414 ft. below the level of the crest of the weir; it was afterwards moved 0.02 ft. higher."

This was the point used by Messrs. Fteley and Stearns in their experiments on velocity of approach, in which they varied the height of

* "Lowell Hydraulic Experiments", p. 107, also Plate XIV, Figs. 9, 10, and 11.

† *Proceedings*, Am. Soc. C. E., May, 1918, p. 734.

‡ "Lowell Hydraulic Experiments", p. 141.

§ *Transactions*, Am. Soc. C. E., Vol. XII (1883), p. 9.

Mr. Nagler.

the weir above the bottom of the channel of approach; and although this point of measurement was not used in all their experiments, the writer adopted it as being representative, since it is also practically equivalent to the point of measurement used in their experiments on the 19-ft. weir.

In all the writer's gauges, the 2-in. pipe connecting with the hook-gauge wells entered the flume normal to the walls. The end of the pipe was carefully dressed with a file and was flush with the inside wall, in no case projecting beyond the wood.* The writer is of the opinion that when all other conditions are the same, the most accurate piezometer would be that which gives satisfactory results with a connection of maximum cross-section and opening with the body of flowing water. Such a piezometer would respond most readily and accurately to fluctuations in the flowing stream, give a result covering a greater average of static conditions, and be less likely to respond to the influence of small stray diagonal currents. A piezometer with a 2-in. orifice and short 2-in. pipe connection with the stilling well, should produce more accurate results than small ¼-in. or ⅜-in. orifices with long rubber hose connections, similar to those used in the weir experiments of Messrs. Fteley and Stearns.

The writer still wishes to maintain his opinion that, in general, large scale weir experiments have been limited to those on low heads, due to the limitations in the size of the measuring basin. Operating under a head equal to the highest one on the writer's weir, the discharge over the Francis suppressed weir would have filled his basin in but 41 sec.; the Fteley and Stearns 19-ft. weir would have filled its enormous basin in but 9 min., and the standard Bazin weir would have filled its basin in less than 1½ min.

Almost all weir formulas are practically identical in their introduction of the more significant variables such as L and H. The main difference is usually defined in their method of introducing the "velocity of approach" correction and its magnitude. Hence, in testing the applicability and accuracy of the different formulas, it would seem that the logical procedure would be to magnify the necessity for the introduction of this factor of velocity of approach, instead of minimizing it; and the formula which is the most accurate when a large velocity of approach correction becomes necessary, is that which most correctly incorporates this element. The writer, therefore, wishes to take exception to Mr. Stearns' statement† that his high head experiments seem to "have little general value, because of the high velocity of the water in the channel of approach", and, for the same reason, he suggests by the title of his paper that his experiments verify the Bazin formula. Mr. Stearns also presents a comparison of the effect of

* *Proceedings*, Am. Soc. C. E., January, 1918, p. 16.

† *Proceedings*, Am. Soc. C. E., May, 1918, p. 729.

Mr. Nagler.

velocity of approach in the extreme case for the Bazin experiments as 0.144 ft. on a weir 0.80 ft. high, and for the Fteley and Stearns experiments as 0.128 ft. on a weir 0.50 ft. high, whereas the writer's maximum case was 0.377 ft. on a weir 3.72 ft. high. Without mention of the measured head on the weir, however, this comparison is worthless and would lead one to infer that the greatest effect was that which occurred in the hydro-chemical experiments. This, however, is not the case. Expressed as a percentage of the discharge over the weir, the effect due to the velocity head of approach in each case is as follows: Bazin experiment, 17%; Fteley and Stearns experiment as much as 25%; and the hydro-chemical experiment, 17 per cent. Actually, therefore, Messrs. Fteley and Stearns, themselves, have presented the Profession with the experiment involving the maximum effect of the velocity in the channel of approach to the weir. It also appears that the writer's experiments are within the limit of those of Bazin on the effect of velocity of approach, and, in verifying the Bazin formula for high heads, there is fair assurance of the applicability of this formula to weirs of other heights discharging water under similar heads.

Far more important than the production of a uniform velocity in the channel of approach seems to be the production of smooth stream line motion in the water approaching the weir. A channel with a mathematically uniform distribution of velocities is not in equilibrium, due to the increased friction near the sides and bottom. A channel of approach of considerable length is not only advisable but necessary to produce the best condition. The conditions may be improved by the addition of screens or baffles; but, in many instances, screens alone, with a short channel of approach, would not produce the desired condition. Messrs. Fteley and Stearns performed experiments in which the channel of approach was so short that it was necessary to place the screens as close as 12 and 7 ft. from the weir; in the latter case, the screens were only 1 ft. from the point of measurement of the head. Bazin intimates that this unfavorable condition may possibly be the cause of the constant differences in the two Fteley and Stearns series of experiments and the discrepancy between their results and those of other experimenters. It is interesting in this connection to note that the production of eddies or a non-uniform distribution of velocities near the weir would tend to decrease the discharge over the weir; whereas, those experimenters using the shorter channels of approach, necessitating the use of screens, secured the smaller discharge, while those using the longer channels of approach, with screens far distant from the weir, or none at all, secured the higher coefficients of discharge.

When the writer mentioned waves of magnitude in the channel of approach for the experiments with the greatest discharge,* he did

* *Proceedings*, Am. Soc. C. E., January, 1918, p. 43.

Mr. Nagler.

not wish to convey an exaggerated impression of the unfavorable condition. In the worst case, the waves were only 1 or 2 in. high, and, being momentary, did not affect the constancy of the hook-gauge readings and, therefore, were not considered objectionable.

The distribution of velocities shown in Fig. 11, was the result of current-meter gaugings taken early in the progress of the hydro-chemical experiments. This condition was improved immediately by shifting the maximum velocity from the left to the center of the stream. The low velocity at the surface was attributed to the floating raft, and disappeared with approach to the weir. The object of the raft was to decrease the surface vibrations. As the ties only sank 3 or 4 in. in a channel from 4 to 8 ft. deep, the writer considered them negligible when the statement was made that the basin was free for 90 ft. above the weir. Fig. 11 shows more than 70% of the section with a velocity greater than 3 ft. per sec. and not exceeding 3 ft. per sec. by more than 10 per cent. Comparatively, this is a far more uniform distribution of velocities than that observed in the Fteley and Stearns experiments on the 19-ft. weir, which Mr. Stearns once thought "quite satisfactory".* In fact, if one computes the velocities shown in Fig. 11 in the same manner in which Messrs. Fteley and Stearns presented the tabular results of their current-meter measurements in the channel of approach, one will find that the arithmetic mean of the individual departures from the average velocity in the section expressed as a percentage of the average velocity, is equivalent to 11% in the Fteley and Stearns channel of approach, whereas, the velocity distribution displayed in Fig. 11 gives a value of less than 5%, or more than twice as good a distribution as that once considered by Mr. Stearns as "quite satisfactory". Furthermore, the kinetic effect of the velocity of distribution shown in Fig. 11 is less than 3% smaller in effectiveness, in the production of "additional discharge due to velocity of approach", than that of a rigidly uniform distribution. A decrease of 3% in the velocity of approach correction is negligible, and represents the maximum effectiveness of screens or other devices which might have been added to the writer's flume in an effort to produce a still more uniform distribution of velocities. The effect of such screens would have been to produce a still greater discharge over the weir, instead of a smaller discharge, as Mr. Stearns seems to intimate.† For the reasons mentioned, there appears to be no foundation for Mr. Stearns' statement that, "judging from the high discharge over the author's weir with moderate heads, the conditions in his case were especially unfavorable". One is rather led to the opposite conclusion, namely, that conditions must have been especially favorable.

* *Transactions*, Am. Soc. C. E., Vol. XII (1883), p. 74.

† For a mathematical treatment of the effect of non-uniform distribution of velocities in the channel of approach, the reader is referred to *Water Supply Paper* No. 200, pp. 17 to 20.

Mr. Nagler.

Fig. 25 involves velocity of approach rather than elimination of it, as Mr. Stearns would have one believe. The diagram may present a comparison of the different weir experiments with some degree of approximation, but its method of preparation is such that it does not present an infallibly true relation. In order to be absolutely correct, each individual experiment should have been treated with a velocity of approach correction differing from the others, in order to reduce the experiment to a channel of infinite depth. This correction is known only within certain limits and cannot be expressed by the mean value found by any experimenter, as these values $\left(\alpha \text{ in } h = \alpha\, v\, \frac{2}{2\,g} \right)$ vary systematically for weirs of different heights and under different heads. Messrs. Fteley and Stearns found that α varied from 1.33 to 1.87,* and adopted $\alpha = 1.5$ only as a mean value. The application of such a mean value of α to all the individual experiments, in an attempt to eliminate the effects of velocity approach, rather involves this factor, and presents the experiments in neither a proper relation to themselves nor to those of others. Likewise, Bazin found that α varied from 2.52 to 1.08, and, in presenting a method comparable with that adopted by Messrs. Fteley and Stearns, suggested the use of $\alpha = \frac{5}{3}$, stating, at the same time, that this method of correction for velocity of approach was not satisfactory. Bazin arrives at the following conclusion:

1st.—That the values of α decrease with decrease of height of weir, and that, for a given height, they first increase with the head, up to a maximum, and then again decrease.

2d.—That the values of K (in the Bazin formula), which vary less than those of α with the height of the weir, become more nearly equal as the head increases.

Furthermore, in his series of experiments on a weir 0.75 m. high, Bazin found a mean value for α equal to 2.21, which would seem to indicate that the application of $\alpha = 1\frac{2}{3}$ to the hydro-chemical experiments on a weir 1.135 m. high, in the preparation of Fig. 25, would give results with a deficient magnitude of correction, even in the average case. There is no assurance that $\alpha = 1\frac{2}{3}$ is the proper correction for any or all of the hydro-chemical experiments shown on Fig. 25. Furthermore, there is evidence that $\alpha = 1\frac{2}{3}$ does not show the individual Bazin experiments in their true location on this diagram. The same statement might also be made of the other experiments shown thereon. As an illustration of the amount to which the selection of the proper value of α affects the location of the experiments in the production of such a diagram as Fig. 25, the writer has prepared Fig. 27, showing the location of the curve representing the hydro-chemical

* *Transactions*, Am. Soc. C. E., Vol. XII, Table 1, p. 12.

experiments reduced to a channel of infinite depth with α equal to different selected values. Fig. 27 shows an exceptionally wide variation in range and, particularly, for the higher heads, a possible variation much in excess of the difference between the results of the various experimenters. It suffices also to show that Fig. 25 does not eliminate the effect of velocity approach, although it may present an excellent attempt to do so. Mr. Nagler.

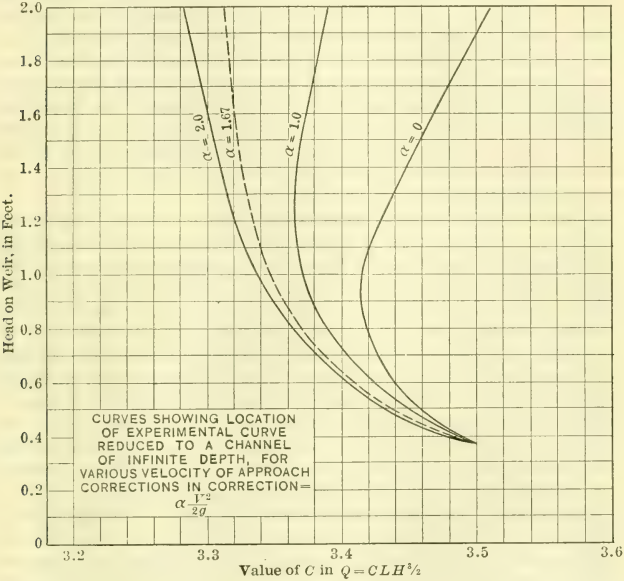

FIG. 27.

A much closer approximation to a correct presentation of a comparison of the different weir experiments with those presented in the writer's paper, has been prepared in Fig. 28. In this diagram, the actual coefficients in $Q = C\ L\ H^{\frac{3}{2}}$, for the hydro-chemical experiments, have been shown for the experimental conditions of velocity of approach under which they were performed. The application of an unknown value of α is thus eliminated. The results of other experimenters have been reduced to like channel conditions, not by attempting to correct their individual experiments, but by reducing their derived formulas. Fig. 28 is merely a graphical presentation of the tabulation expressed in

Mr. Nagler.

Table 4. It is similar to Fig. 25, except that it gives results for a channel 3.72 ft. deep. It presents a true comparison of the results of other experimenters with the writer's actual experiments. An inspection of Figs. 24 and 28 renders untenable Mr. Molitor's statement* that in every case the Bazin experiments are smaller than those of the writer, and his conclusion that there is a constant or periodic error in the writer's experiments appears to be far from the truth. The hydro-chemical experiments do not give greater discharge than those of Bazin, except for the three experiments on the lowest heads, and even these fall within the limits of the Bazin experiments themselves. They verify the Bazin formula quite well for all heads, as well as the King formula and the Lyman diagrams for suppressed weirs, the latter two having been recently derived after careful study of all standard weir experiments to date. Likewise, the writer is pleased to note the excellent agreement in the formula proposed by Gustav Ritter von Wex, presented in Mr. Molitor's discussion.

Some writers have mentioned the fact that the Bazin formula did not fit the Bazin experiments. This statement apparently ignores the fact that the Bazin formula was not based on the experiments on the standard weir alone, but on a total of 371 experiments on weirs of different dimensions, an aggregate number equal to more than all other so-called standard weir experiments combined. His formula does fit the entire series, to a remarkable degree. If Messrs. Fteley and Stearns had attempted such a generalization of results, considerable difficulty would have been experienced in reconciling their two series of experiments on weirs of only two different dimensions, and their final result which they based on the work of Francis, as well as their own, departs more widely from its few basic experiments, than the Bazin formula does from the many experiments from which it is derived.

In general, a few experiments confined to a limited range in conditions, no matter what precision may be claimed for them, do not form as good a basis for the evolution of a formula as a greater number distributed through varying conditions and over a wider range in head, the precision of which may be somewhat inferior than in the former case. If the few experiments of Messrs. Fteley and Stearns on the 19-ft. weir so well determined the weir formula, the writer is curious to know why they finally chose a general weir formula which departs widely from these experiments, fitting more closely those of Francis and their own experiments on the 5-ft. weir. The Rehbock formula furnishes another illustration of this same principle. The experiments were made on so small a scale (the weir being only 1.64 ft. long, from 0.41 to 1.64 ft. high, and with heads on the weir of from 0.03 ft. to 0.59 ft.), that it seems ridiculous to attempt to classify

* *Proceedings*, Am. Soc. C. E., March, 1918, p. 521.

Mr. Nagler.

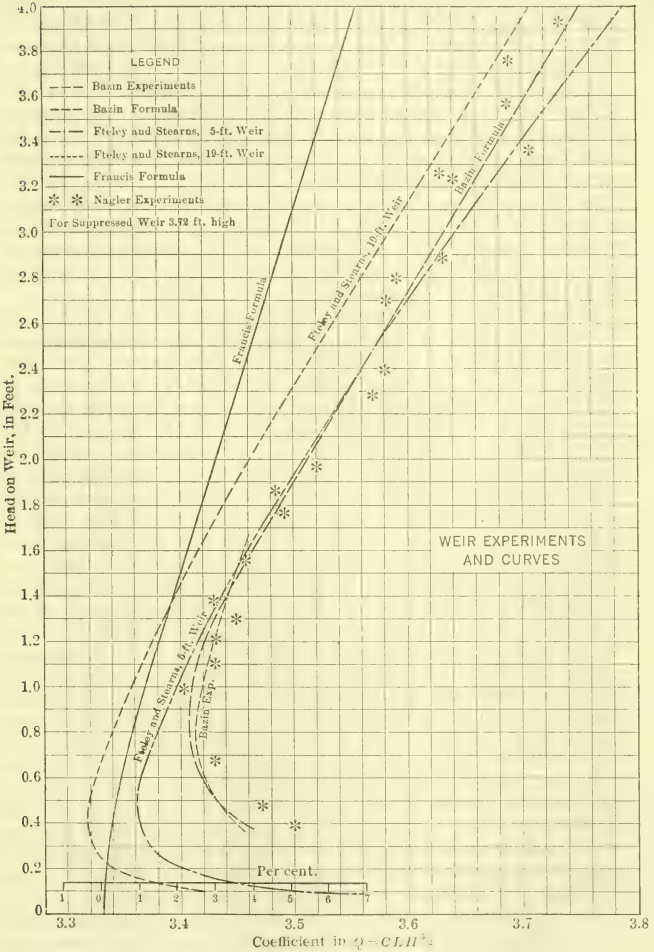

FIG. 28.

Mr. Nagler.

this work with large-scale experiments like those of Bazin, Francis, and Fteley and Stearns. The representation of the Rehbock experiments by the formula on Fig. 25 is quite misleading, since there are no experiments above a 0.59-ft. head on the weir and extended down to a 0.03-ft. head. A true representation of his work would be shown by a curve starting with 0.59 ft. on the weir, following that shown on Fig. 25, and extending beyond it in a downward direction across the entire chart, intersecting the right-hand boundary ($C = 3.6$), at about 0.055-ft. head. Mr. Stearns is also in error when he states that the Rehbock experiments above 1 ft. on the weir show very little change in coefficient with increasing heads, since Rehbock performed no experiments above 0.59-ft. head on the weir to indicate such a proposition at all; and the extension of the Rehbock formula to these higher limits is entirely unwarranted.

In contrast to the refined work of Bazin, in passing a given quantity of water over weirs of different lengths with side contractions suppressed, thus forming the basis whereby his formula gives the variation in C, which is greater than that of other experimenters, as shown by Mr. Stearns,* the Tremont turbine tests involving the side contraction of weirs should have but little weight. In fact, if Mr. Stearns had used the correction for side contractions evolved by Francis for this very set of experiments, he would have been forced to quite a different conclusion. Mr. Francis† performed these experiments with the intention of determining the effect of side contractions, and developed the formula for these Tremont turbine tests, namely, $L = (l - 0.05\ nh)$, where L equals the corrected length; n, the number of contractions; l, the actual measured length of the weir; and h, the observed head. The change in the coefficient of the second term of the binomial from 0.1 to 0.05 quite materially affects the results in Table 6; and since Mr. Francis himself finally adopted 0.1 for the value of the coefficient merely because of its simplicity, the writer recomputed Table 6 on the more correct basis. The results show the "average difference" in the case of the Fteley and Stearns formula to be + 1.13%, in the case of the Rehbock formula, + 1.03%, and the Bazin experimental curve, — 0.43%. In other words, the Fteley and Stearns and Rehbock formulas do not increase as rapidly with decreasing heads on the weir by more than twice the amount which the Bazin experimental curve is found to exceed the proper rate of increase as indicated by the Tremont turbine experiments. A correct computation of these experiments, therefore, shows far better agreement with the Bazin formula than with the other two.

Mr. Molitor calls attention to the Rafter experiments, with heads on the weir as great as 4.67 ft., noting that they do not agree with

* *Proceedings*, Am. Soc. C. E., May, 1918, p. 733.

† "Lowell Hydraulic Experiments," p. 86.

the hydro-chemical experiments. Fig. 29 has been prepared to show a graphical comparison of the Rafter experiments with those of the writer. This diagram is similar to Fig. 28, being based on a weir 3.72 ft. high. The coefficients for the Rafter experiments which were on a weir 5.2 ft. high, have been reduced to equivalent coefficients for a weir 3.72 ft. high, by correcting the observed head by an amount equal to the difference in velocity of approach correction on weirs 5.2 ft. and 3.72 ft. high, respectively. A mean value of $\alpha = 2.2$ was used, Mr. Nagler.

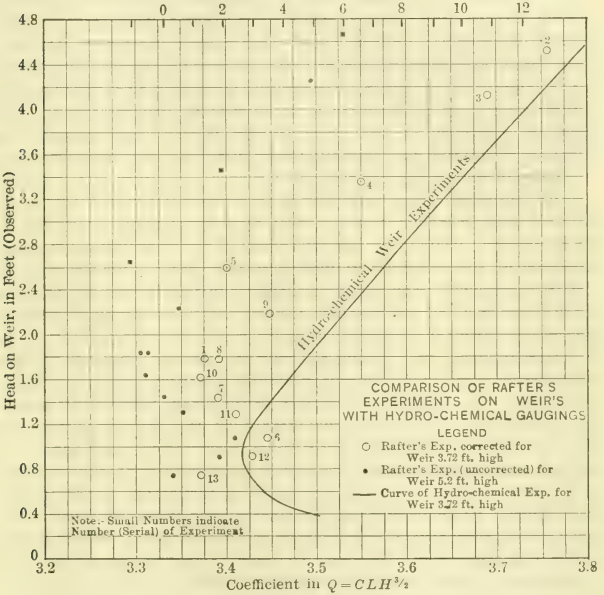

FIG. 29.

being that found by Bazin in his experiments on velocity of approach for the weir most nearly equal to 3.72 ft. This is probably as close as the true correction could be approximated, and involves but little error, due to the fact that the discharge over the weir in the Rafter experiments was computed by the Bazin formula itself. The diagram reveals several facts: First, that the Rafter experiments are quite inconsistent within themselves, departing as much as 2% from the best curve which could be drawn through the series, even in instances

Mr. Nagler.

at the lower heads; second, that there are only five experiments above 2 ft. in head, in contrast to eleven hydro-chemical experiments above this head; and these five high head experiments represent discharge coefficients from 1 to 5% less than the writer's experiments, coming into closer agreement for the higher heads; and third, that Experiments Nos. 6 and 12 in the Rafter series give higher coefficients than the hydro-chemical experiments, and, hence, Mr. Molitor's statement is not strictly accurate.

The Rafter experiments were in no sense volumetric experiments. A weir was used to gauge a weir of another length with different channel conditions; and it would hardly seem that they should be given much weight alongside of more accurate methods for determining the quantity of water passing over a weir. The discussion* of Mr. Rafter's work by Gardner S. Williams, M. Am. Soc. C. E., offers abundant proof as to the error in the Rafter experiments, error sufficient, if allowed for, to make them come into close agreement with the hydro-chemical experiments.

Mr. Molitor states that the hydro-chemical method of gauging has only high relative accuracy, and that its absolute accuracy must yet be proven. Can it be that the chemist has been mistaken and in processes of quantitative analysis has only been securing results of relative accuracy? The works of Collet, Stromeyer, and Mellet should afford some proof of the absolute accuracy of hydro-chemical gaugings. Mr. B. F. Groat has also presented some checks between hydro-chemical gaugings and volumetric and gravimetric gaugings, in which he found the two methods giving results agreeing within 0.2 and 0.3 per cent.† Mr. Molitor continues to mention sources of constant error which he fears may have existed in the writer's experiments. He mentions the effect of alkalis, acid, etc., in the pond water. The method of special dilutions in which laboratory solutions are made up in a series of trials, by mixing samples of the actual pond water and salt solution used in the test, absolutely eliminates all possibility of error from this source. Furthermore, if imperfect velocity distribution had affected the time that the salt reached the sampling station, its disastrous results would have become evident in a poor distribution of strength of samples. Table 2 shows not even moderate evidence of this, and also reveals that the whole mass of water as it passed the sampling section had practically the same concentration of salt. If differences had been observed in the samples, there might have been something more than speculation in Mr. Molitor's fears with regard to the location of sampling holes, peripheral flow, unequal distribution of velocities, and frictional losses in sampling pipes.

* *Transactions*, Am. Soc. C. E., Vol. XXVI, pp. 631 to 635.
† *Transactions*, Am. Soc. C. E., Vol. LXXX, pp. 1085, 1270.

Mr. Nagler.

Water did not flow from the dosing station to the sampling point in imaginary stream lines, in which case the portions or elements retarded by friction would have arrived later; but there was interchange, many times, between the top and bottom and side elements, due to cross-currents and turbulence. This mixing was especially encouraged by the construction of baffles and a submerged weir in the flume between the two stations. The salt detection points in the water moving with low velocity, near the sides of the flume, proved that the salt solution traveled from the point of dosing to the sampling station, not with a velocity represented by the slow movement of the current in which the points lay, but equal to, and in some instances greater than, the mean velocity of the water in the flume. Finally, Mr. Molitor's last objection that there might be loss of salt by absorption in the flume walls, seems to be merely "straining at a gnat," when one considers that the flume walls are already soaked and filled with water to their capacity, and that, at best, this quantity of water absorbed in the walls represents only a small fraction of a percentage of the total volume of water discharged over the weir in any experiment.

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CONSTRUCTION METHODS USED IN BUILDING THE LOWER RESERVOIR DAM OF THE BALMORHEA PROJECT

Discussion

By Vernon L. Sullivan, M. Am. Soc. C. E.*

Mr. Sullivan

Vernon L. Sullivan,† M. Am. Soc. C. E. (by letter).‡—Since the paper was written, the Balmorhea Dam has been put to a severe test. Early in March, 1919, a hard wind swept down the draw at practically right angles to the dam, the waves hitting the dam squarely. The storm at times almost reached the proportions of a hurricane, and was so severe that men could not stand on the dam.

It had been planned, when the earth had had time to settle, to put a vertical 2-ft. coping wall, with an overlying cap, on top, to bring the concrete slab rip-rap up to the crest of the earth dam, so as to turn back any waves that might reach that height. This had not been done when the storm occurred. The water in the reservoir was at an elevation of 137.5 ft., or ½ ft. above the change in the slope from a 2½ to 1 to a 1½ to 1, and 9½ ft. below the crest of the dam.

During the storm the waves rolled up the concrete slab rip-rap to such a height that the wind would catch under them and shoot them up the slab and over the dam; many of the waves never touched the earth dam at all, the water hitting the ground on the back side of the dam below the lower toe.

This continual action for 36 hours washed down the earth at the back of the earth dam to a point where it had been settled and packed by irrigation process during construction.

* Author's closure of paper published in April, 1918, *Proceedings*.

† El Paso, Tex.

‡ Received by the Secretary, October 14th, 1919.

Mr. Sullivan.

On the front of the dam, the water got behind the concrete slab rip-rap and broke it down to an elevation of 137 ft., for a distance of nearly 1 000 ft., at a point where the wind and wave action was most severe. Very little damage was done below the point of the change of slope in the concrete slab rip-rap.

Two lessons were learned: First, that a concrete reinforced slab rip-rap is good protection for earth dams where the slope is $2\frac{1}{2}$ to 1 or flatter; and, second, that on a concrete slab rip-rap the surface should be roughened by setting in rocks in the surface of the concrete, so that they will stick up above the surface line to break up the waves.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PAPERS AND DISCUSSIONS

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ON A NEW PRINCIPLE IN THE THEORY OF STRUCTURES

Discussion*

By H. T. Eddy, Esq.

Mr. Eddy.

H. T. Eddy,† Esq. (by letter).‡—There is a certain limitation to Mr. Maney's method§ which seems to make his arch analysis inapplicable to the transverse frames of ships; and even were this obstacle removed in some way, the moment of inertia of reinforced concrete arch sections suffers such discontinuous changes under stresses, due to combined bending and compression, depending on which of these two kinds of stress predominates, that the method would require radical emendation to make it afford a suitable basis for investigating the design of concrete ships.

The limitation just mentioned may be expressed by stating that the method is necessarily restricted to cases where every one of the applied forces of the arch loading acts in a direction perpendicular to the line, AB, joining the ends, A and B, of the member which acts as an arch. That this is necessarily so is evident from the fact that the moment, M', of all the applied forces, including the reactions of the supports, but excluding the restraining moments at the supports, must be calculated, as is correctly stated by Mr. Maney, on a statically determinate basis. This requires that the magnitudes of both the opposing thrusts, F_A and F_B, acting along AB, at A and B, respectively, shall be known.

* Discussion of the paper by George F. Swain, Past-President, Am. Soc. C. E., continued from September, 1919, *Proceedings*.

† Minneapolis, Minn.

‡ Received by the Secretary, October 17th, 1919.

§ *Proceedings*, Am. Soc. C. E., August, 1919, p. 531.

Mr. Eddy.

These thrusts, however, are statically indeterminate in case there is a component, P, of any force which is applied to the arch rib at any point that acts in a direction parallel to AB, since, in that case, the algebraic sum of the reactions along AB that hold P in equilibrium is $F_A + F_B = P$, in which the actual magnitudes of F_A and F_B are statically indeterminate, not only for an arch, but for a straight member as well. For it is evident that a force, P, applied longitudinally to a straight piece, AB, at some point, Q, intermediate between its extremities taken as fixed, will awaken reactions at A and B which are not statically determinate, but are dependent on the relative length and elasticity of the segments, QA and QB. This is also true of an elastic arch, AQB.

In general, the thrusts, F_A and F_B, at the supports are statically determinate only in case $F_A + F_B = 0$, that is, in case no one of the applied forces has a component parallel to AB.

However, since hydraulic pressures act normal to the exterior surface of a ship, any curved member of a transverse frame functioning as an arch rib and subjected to these pressures must be subjected to components of those pressures, which act along the line, AB, joining its extremities. Hence, the proposed method based on zero pressures parallel to AB is inapplicable to curved members of ship frames.

Just how this limitation restricts the proposed analysis may be made more clear by the following discussion of the principles involved in establishing and interpreting Mr. Maney's Equation (1), which is an expression in algebraic form of the fundamental principles of the loaded elastic arch with level supports, as first made public by the writer in his paper on "Certain New Constructions in Graphical Statics."*

In considering arch action in general for vertical loads, it may be stated that when the axis of the arch rib coincides in position and direction with the line of resultant pressures due to all the applied forces—which line is identical with the equilibrium polygon of those forces—then the structure constitutes an equilibrated arch, as it is called by Rankine, and the arch action of a rib of this shape provides, by reason of its shape alone, all the resisting moment that is required in order to hold in equilibrium the moments of the applied forces, and no bending moment whatever is exerted by the arch rib itself in resisting the applied moments. The entire stress in the rib in this case consists of direct compression along its axis. An equilibrated arch coincides with a catenary curve of the loads placed in an upright position.

* Read before the American Association for the Advancement of Science at Buffalo, N. Y., in 1876, and, later, published in the *American Journal of Mathematics*, Vol. I, No. 1, and in *Van Nostrand's Engineering Magazine*, and republished in the writer's book entitled "Researches in Graphical Statics", New York, 1878.

Mr. Eddy.

Let A and B be the points of support on the axis of an arch rib, AQB, as in Mr. Maney's Fig. 29, in which AB is horizontal and Q any point on the curved axis. If the point, Q, does not also lie on the equilibrium polygon of the applied forces corresponding to the actual thrust, F, of the arch, then this is not an equilibrated arch, because the curved axis of the arch deviates at this point, Q, from the equilibrium polygon and, consequently, the arch rib itself must sustain some bending moment, M, and thus furnish part of the moment that resists the total moment, M', due to the applied forces.

Let Q' be the point where the vertical at Q cuts the equilibrium polygon, and Q'' the point where it cuts AB; and let r = the total rise of the arch, and $QQ'' = vr$, then:

$M' = F \times Q'\,Q''$ = the total moment at Q of all the applied forces as found for a simple beam, AB, that is, the moment due to all the forces and reactions except end moments.

$M = F \times Q'\,Q$ = that part of the moment M' resisted by the bending moment in the arch rib.

$Fvr = F \times Q\,Q''$ = that part of M' resisted by arch action by virtue of the thrust, F, along AB, and the equal horizontal component of axial compression at Q.

$Fvr + M$ = total resisting moment due to arch action and to the bending moment in the rib.

Let $AB = L$, $AQ'' = aL$, and $BQ'' = bL$, and let M_A and M_B be the restraining moments at A and B, respectively. Then, aM_B and bM_A are the resisting moments at Q due, respectively, to M_B and M_A.

When the applied forces are perpendicular to AB, the conditions of equilibrium of the arch rib, AQB, evidently require at every point Q, that the sum obtained by adding the bending moment, M, of the rib itself to the moment, Fvr, representing the arch action, shall be equal to the total statical moment at that point due to all the forces applied to the arch, including not only the vertical loads and the reactions of the supports, but also the effects of the restraining moments at A and B.

Hence, we obtain Mr. Maney's Equation (1), namely,

$$M + Fvr = M' + aM_B + bM_A \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

in which the intrinsic sign of F has been reversed for convenience.

The total statical moment, M', may be taken to consist of two parts, as follows: One part due to the loads and the vertical components of the reactions which may be constructed by drawing the equilibrium polygon for a simple beam supported at the ends with a pole distance = F, and carrying the applied loads. The vertical

Mr. Eddy.

ordinate at any point, Q, of this polygon multiplied by F will give the moment at Q of the loads and the vertical components of the reactions at A and B. The other part of M' is Fvr, the moment of the horizontal component of either reaction. Since, however, both sides of Equation (1) include the same quantity, Fvr, the first side explicitly, and the other side implicitly in M, they might be expressed so as to cancel each other, and it is, consequently, wholly immaterial what value may be assigned to F, the horizontal component of the reaction at either support, or, what is the same thing, the direction of one reaction may be arbitrarily assumed provided all the loads act perpendicularly to AB, for Equation (1), in fact, has to do only with the moment of the vertical forces.

As already stated, another question of fundamental importance in reinforced concrete under combined compression and bending is a correct method of calculating the value of the moment of inertia of any composite cross-section, especially at points where the applied moments are large.

The value of I in a combination of concrete and metal depends, not on the area of the concrete and steel alone, but on the condition of stress normal to the section. If the condition of stress is that of simple flexure, with no longitudinal thrust, then I depends entirely on the steel and its position in the matrix, together with that part of the concrete which is under compression. If, however, the entire section is under compression, then I depends on the total area of the concrete and the area of the steel combined.

As an example, consider the moment of inertia of a column supporting a floor. If the load on the column is such that the total area of the concrete is under compression, then this total area enters into the moment of inertia of the column section and must be taken into consideration in the apportionment of moments between the column and the floor. Whereas, if the load is insufficient to cause the column to be under compression throughout its full area, that part of the section of the concrete which is under tension, does not enter into the determination of the moment of inertia, but must be entirely disregarded. Deflections may vary in such constructions nearly 100% with the variations of the moment of inertia of the same cross-section of metal and concrete depending entirely on the state of longitudinal stress in the columns. Under Mr. Maney's discussion, no attention is paid to this important matter, and the validity of his analysis must depend on the correctness of the determination of I at the different sections considered, even in cases where the applied loads have no components parallel to AB.

Professor Burr's* objections and emendations do not seem to be well taken in his attempt to identify Dr. Swain's formula for the

* *Proceedings*, Am. Soc. C. E., September, 1919, p. 613.

Mr. Eddy.

actual rotation, α, which occurs at any section of a piece due to the loads and restraints to which the whole piece is subjected, with the total change of slope or curvature between two given sections of the piece in accordance with Rankine's formula:

$$i_2 - i_1 = \int^2 \frac{M_s \, d\, l}{E\, I}$$

where i_1 and i_2 are the slopes at given sections, A and Q, of a piece, AB.

It is only in certain particular cases that the change of slope, or the total curvature produced between A and Q as found by this equation, is the same as the rotation at Q, since they are the same only when the piece is fixed at A in such a manner that no rotation occurs at that point. Then, and then only, do the formulas for slope and rotation give identical results.

If, however, the piece is fixed at A and free at B, then a unit moment applied at Q must be held in equilibrium by a unit resisting moment at A, and there is a unit bending moment, M_r, produced by it at every point of AQ, and no bending moment, M_r, in BQ.

It is self-evident, however, that, in Dr. Swain's Equation (5), M_r cannot in general be equal to unity, as Professor Burr asserts, because the limits of the integrations in which it occurs extend, all told, from A to B, although the section where the rotation occurs is at Q, because the integration above for the change of slope extends from A to Q only. In other words, if $M_r = 1$ at all points of AB that would require:

$$\int_A^Q \frac{M_s \, d\, l}{E\, I} = \int_A \frac{M_s \, d\, l}{E\, I},$$

where the first member is the change of slope and the second member is the rotation, in case M_r is assumed to be equal to unity.

Hence,
$$\int_A^Q \frac{M_s \, d\, l}{E\, I} = \int_A^Q \frac{M_s \, d\, l}{E\, I} + \int_Q^B \frac{M_s \, d\, l}{E\, I},$$

$$\text{or, } 0 = \int_Q^B \frac{M_s \, d\, l}{E\, I},$$

which is absurd.

The conclusive demonstrations of Castigliano and Müller-Breslau, as shown clearly by Professor Church and Mr. Mensch, in their extended and original elucidations,* make it certain that Dr. Swain's formula contains no material error when properly interpreted.

It should be particularly noted that the value of M_r depends on the same restraints and the same manner of support that are effective to determine the distribution of the applied moments that produce the moment, M_s, actually operating.

* *Proceedings*, Am. Soc. C. E., May, 1919, pp. 315 and 323, respectively.

Mr. Eddy.

For example, in a beam of length, $AB = L$, uniformly loaded and rigidly fixed in direction at both A and B, the moment polygon due to a unit couple applied at Q, when $AQ = aL$ and $BQ = bL$, consists of two horizontal lines such that in the segment, AQ, we have $M_r = b$ and, in BQ, we have $M'_r = -a$. The sides of the polygon are straight at the right and left of Q, because the only applied forces in the polygon, the ordinates of which represent M_r, are the forces of a couple of unity applied at Q. The fixity of the ends requires that the positive moment area shall equal the negative area, as they do in this case, namely, $aLM_r = -bLM'_r = abL$.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PAPERS AND DISCUSSIONS

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SEWAGE AND WASTES DISPOSAL FOR THE UNITED STATES ARMY

Discussion*

By A. L. Sherman, Assoc. M. Am. Soc. C. E.

Mr. Sherman.

A. L. Sherman,† Assoc. M. Am. Soc. C. E. (by letter).‡—It has been the writer's privilege, during the past eighteen months, to be associated with the author in the design of the various structures connected with the sewage treatment plants at the different army camps and permanent posts throughout the United States, and the experience gained in overcoming the many difficulties encountered in this work has been very valuable. That the problem of successfully treating the concentrated, heavily grease-laden, army sewage has been practically solved is now generally admitted by those in touch with recent developments.

The early difficulties in the operation of the type of sewage tanks adopted for use in the army cantonments have been assumed by many to be functions of the tank itself, rather than an inherent part of the problem of treatment. The problem of treating a sewage containing 450 parts per million of suspended organic matter, including 150 parts per million of grease, besides an indeterminate quantity of garbage, was one which was new to sanitary engineers. The low unit capacity, 10 gal. per capita, used for the tanks first constructed, was selected with the realization that the great saving in first cost would be in part offset by increased cost of operation. It was also assumed

* Discussion of the paper by Leonard S. Doten, M. Am. Soc. C. E., continued from September, 1919, *Proceedings*.

† Washington, D. C.

‡ Received by the Secretary, November 25th, 1919.

Mr. Sherman.

that the maximum population, on which the 10-gal. unit capacity was based, would be reached only at intervals, and that the average would be much below this maximum. Lack of shipping and subsequent increases in the army programme resulted in the camps remaining at full strength during the entire winter and spring of 1917-18.

The removal of 70% of the suspended organic matter by sedimentation would result in the deposition in the tanks of 4.1 cu. ft., or 33 gal. per annum, of sludge containing 85% of moisture. This volume would be reduced perhaps 30% by digestion, or to 23 gal. per capita per annum. The grease alone, if entirely retained in the tanks, would amount to 19 lb. per capita per annum, or, on a 50% moisture basis, 38 lb., or 4.5 gal. of sludge due to grease. It should also be noted that the tanks were placed in use just prior to the winter season of 1917-18, and were immediately loaded above even their rated capacity without any opportunity for a gradual "ripening", and were practically without attention for the ensuing six months. To the writer, the remarkable feature of the performance of these tanks is that they functioned at all.

As a contrast to the above, the results obtained during 1919, with competent operation, grease traps of the type described by the author installed throughout the camps, some minor changes in the design of the sewage tanks, and, in some cases, increases in the capacity per capita, furnish a more reliable index of the true value of this type of plant for sewage treatment.

The plant at Camp Merritt, N. J., which was used during 1919 as a debarkation camp for a large percentage of the troops arriving at New York City, is the most available one for inspection by members of the Society in and near New York City, and is a fair example of this type. The operation of the water supply and sewerage systems at Camp Merritt have been under the charge of Capt. Paul Molitor, formerly in charge of the operation of the sewage treatment plant at Chatham, N. J. Capt. Molitor has had in direct charge of the sewage treatment works, Mr. W. R. Teats, formerly of the Engineering Staff of the Pennsylvania State Board of Health, and they have taken great pride in the sewage treatment plant, which, contrary to the custom at many municipal plants, has been made attractive to the eye by grading, grassing, and the construction of gravel walks.

Capt. Molitor and Mr. Teats state that camp sewage is much more difficult to treat than municipal sewage, and that, on account of the large quantity of scum-forming material present, it would be practically impossible to handle the sewage in a two-story tank. This plant, during the spring of 1919, cared for the sewage of an average population of 26 000, with a gross per capita capacity of 28 gal., and a 95% removal of settleable solids.

Mr. Sherman.

The following extract from a recent report by Capt. Molitor is interesting, in view of various opinions expressed as to the ability of this type of plant to produce satisfactory digestion of sludge:

"During the month, 405 cu. yd. of liquid sludge was drawn from tanks to sludge drying beds. All of this sludge was of excellent quality, dark in color, practically odorless; in fact, no odors could be detected from it more than 50 ft. from the sludge drying beds. Weather conditions being favorable this sludge dried to forkable condition in from 5 to 7 days. The sedimentation tests show a high percentage of removal of suspended soils by the tanks, proving that if these tanks are operated with reasonable care and intelligence they will perform the work for which they are intended. No complaints have been received as to objectionable odors emanating from the plant. The plant continues to operate in a normal and satisfactory manner."

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PAPERS AND DISCUSSIONS

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AMERICAN HIGHWAYS

An Informal Discussion*

By William E. Woolley, Assoc. M. Am. Soc. C. E.

Mr. Woolley.

William E. Woolley,† Assoc. M. Am. Soc. C. E. (by letter).‡—This discussion on highways is very interesting, and several of Mr. Breed's remarks might apply very aptly to English conditions. Many English highways which formerly were suitable for ordinary traffic, have proved to be totally inadequate when subjected to modern traffic conditions, with its heavy motor lorries, etc., owing to their non-rigid foundations, and to the unsuitable material used for their surfaces. This has been most marked during the war, when fleets of heavy military motor lorries were in constant use, and at a time, too, when there was little available material and labor for repairs, and a road-stone control besides.

Often in the past, the cheapest stone in the district was made use of because of its cheapness. This, in many cases, did not entail the use of durable and tough qualities of metaling. There has also been a marked absence of foundations suitable for carrying modern weighty vehicles.

In order to stand modern traffic conditions in towns, care, of course, must be taken that a thoroughly firm and solid foundation of sufficient thickness is provided, a suitable material being concrete, which is being much advocated in England at the present time. The surface should be of durable material suitable for the particular kind of traffic to which the road is subjected. The road should be constructed on the most permanent and soundest principles. It has been established that ordinary macadam roads are not suitable for withstanding the heavy

* Continued from August, 1919, *Proceedings*.

† London, England.

‡ Received by the Secretary, September 27th, 1919.

Mr. Woolley.

modern traffic in big towns. Weak, non-rigid foundations are often denoted by sinkage in the center and rising at the sides.

In regard to English roads, it is noteworthy that, having in a great degree been neglected during the war period, many are now in such a bad condition that the authorities are reconstructing them. Several of the main London roads are at present being dealt with in this manner, and the writer knows of several county roads undergoing similar treatment, a stretch of one-half, longitudinally, being finished at a time, so as not to close the road to traffic.

It is reported that the British Government, through the Road Board and the County Councils, is to assist the authorities in carrying out road works, by making grants amounting in the aggregate to about £10 000 000.

AMERICAN SOCIETY OF CIVIL ENGINEERS

INSTITUTED 1852

PAPERS AND DISCUSSIONS

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WATER SUPPLY FOR THE CAMPS, CANTONMENTS, AND OTHER PROJECTS BUILT BY THE CONSTRUCTION DIVISION OF THE UNITED STATES ARMY

Discussion*

BY SAMUEL A. GREELEY, M. AM. SOC. C. E.

Mr. Greeley.

SAMUEL A. GREELEY,† M. AM. SOC. C. E. (by letter).‡—All who served as supervising engineers for the construction of the National Army camps, will feel grateful to Mr. Maury for his excellent and generous paper on the water supply work of the Construction Division. The writer's work was at Camp Custer, Mich., in 1917, as Consulting Engineer, in charge of the water supply and sewerage, and, in 1918, as Supervising Engineer for a 40% extension to the camp, which brought its total capacity to about 50 000 troops. It is thought that some additional data having particular reference to construction and operation will prove helpful, with a reference to several more detailed descriptions. The writer's connection with both construction periods enabled him to acquire a perspective after the first rushing season of 1917 and prior to the second period which began in August, 1918.

He first visited the site of Camp Custer on June 12th, 1917, and several days later sent a preliminary report to Washington covering the water supply, sewerage, highways, and railroad connections. On June 29th, he went to Washington for a conference. The helpfulness of the Advisory Engineer for Water Supply and his staff was thus early discovered, and thereafter this assistance was sought from time to time through conference and by correspondence.

* Discussion of the paper by Dabney H. Maury, M. Am. Soc. C. E., continued from September, 1919, *Proceedings*.

† Chicago, Ill.

‡ Received by the Secretary, October 25th, 1919.

Mr. Greeley.

Organization.—It was realized during the 1917 experience that a clear-cut organization with definite responsibilities was of paramount importance in expediting the work. This organization was definitely accomplished in 1918. The office of Executive Engineer was especially helpful, as it handled all office details, including matters relating to personnel, reports, weekly meetings, transportation, and the like. At the start each division engineer was given definite instructions relative to keeping permanent records of the work as built, cost records, and data for reports to Washington. This all helped greatly in finally winding up the work.

Progress.—It was also found that complete up-to-the-minute progress records were essential to finishing the work on scheduled time and to maintaining pressure where it was most needed. A special progress department of three engineers was formed. The duty of this department was primarily to receive, tabulate, and correlate the daily progress records of the various divisions. Daily reports were submitted by the divisions to the Progress Engineer, which he charted for the Constructing Quartermaster and the Supervising Engineer. From these charts, weekly reports were prepared for the Washington office.

The analysis of progress from day to day was based on time-labor rather than on cost, and cost summaries were carried separately. This was done to meet the war demand for rapid work. The estimated relation between time-labor and cost for the various divisions of the work, as used on the Camp Custer Extension (1918), is given in Table 2.

TABLE 2.

Division.	Percentage of Total Work:	
	Time-Labor Basis.	Cost Basis.
Buildings	63	77.4
Water supply	12	9.5
Sewerage	10	3.1
Roads	7	3.35
Railroads	5	3.35
Outside electrical	3	9.3
Total	100.0	100.0

A daily general progress chart was posted, showing the essential elements. The linear feet of water pipe, sewer pipe, and concrete road built each day showed the future rate of progress necessary to completion by a given date and assisted in determining the number of trenching machines needed, etc. The delivery of materials also influenced this feature.

Mr. Greeley.

The Progress Engineer was also called on to keep in touch with the inspection of the work, so as to afford an outside disinterested check on each division as to progress and workmanship.

Sanitation.—Mr. Maury mentions the epidemic of influenza as one of several items which combined to increase the cost of the work. The extension to Camp Custer was started just as the influenza began to develop in the Middle West. To reduce it as much as possible, and to maintain the construction camp in a clean, healthy condition, a division of sanitation was organized. The results were gratifying. From October 6th, 1918, when the working force was 1 281, to November 15th, 1918, when it was 2 572, there were 4 cases of influenza and 1 case of pneumonia, and altogether only 14 cases of sickness requiring the attention of a physician. At this time, 65% of the work was completed. From November 15th to December 31st, 1918, when the working force fell from 2 572 to 1 080, and 90% of the work had been done, only 10 more cases of sickness occurred. This was accomplished by active attention to all the details of sanitation, including water supply, bunk houses, stables, restaurants, cleaning of grounds, personal cleanliness, etc. In connection with the water supply, a quickly set-up drinking fountain, of which fifty were set about the work, was used. During the active period of construction the sanitary squad comprised 80 men, of whom 23 were on night duty. It is believed that these results not only maintained a good working force, but also increased applications for work as the healthfulness of the construction camp was well known in labor circles throughout Michigan and the adjoining States.

Construction.—The water distribution system was built almost entirely of wood pipe. In 1917, the bells of all cast-iron fittings were ground to fit the tenons of the wood pipe. During 1918, standard fittings with lead rings were used. The bulk of the trenching was done by machine, the average rate of progress in 1918 being 342 ft. per machine day. The work was slowed up by the difficulty of securing cast-iron fittings. On the completion of a section of the distribution system, the pipes were flushed and "hypo" was pumped in until bacterial analyses showed the water to be safe.

At the pumping station, the principal feature of the 1918 work was the erection and cutting in of new units without interrupting the service. This was done with a total shut-down of 53 min., during which time the camp was supplied from storage. Two motor-driven and one gasoline-engine-driven centrifugal pumps were installed and connected to the wells built in 1917. As nearly as could be ascertained, the cost of 8 and 10-in. wood mains in 1918 was $2 per ft.

Operation.—One of the satisfactory features of the camp work was the opportunity of putting the works into operation. At the close of the 1917 construction period, tests of the centrifugal pumps were made

Mr. Greeley.

and characteristic curves drawn. An operating outline was thus determined. In addition, a chart was prepared for recording daily the camp population, the coal consumption at heating plants, and the water consumption daily and per capita. A study of fixture losses in lavatories was made, and a preliminary list of items for the regulation of consumption was prepared.

Summary.—The writer believes that the construction of the camps was well done, all things being considered, and that one of the outstanding features was the use of the country's engineering resources, marshalled and directed through the Washington office, as outlined by Mr. Maury. No serious errors have appeared.

AMERICAN SOCIETY OF CIVIL ENGINEERS
INSTITUTED 1852

PAPERS AND DISCUSSIONS

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CONTRACTS—A COMPARISON OF "COST PLUS" WITH OTHER FORMS

Discussion*

By Messrs. F. Lavis, Missac Thompson, F. H. Frankland, J. Waldo Smith, Edward F. Hammel, Lazarus White, Arthur P. Davis, Henry H. Quimby, J. P. H. Perry, Henry B. Seaman, Frederick Glaeser, George D. Snyder, F. G. Baum, George Perrine, P. L. Reed, Walter H. Wheeler, E. G. Walker, and J. A. L. Waddell.

Mr. Lavis.

F. Lavis,† M. Am. Soc. C. E. (by letter).‡—The author is evidently much impressed by the virtues of the so-called "cost plus" forms of contracts and the defects of the "lump-sum" and "unit" forms, but also evidently has a suspicion that there is a "nigger in the woodpile somewhere". It would seem to be almost self-evident that all three forms of contracts have their use at appropriate times and places.

The fact that the "cost plus" form has been used so frequently during the last three or four years, shows its adaptability to abnormal conditions, such as those which have existed during the war period when everything has been so unsettled that no one could conservatively venture a prediction as to the future. During this period, not only the Government but manufacturers and others have required works to be carried out almost regardless of cost. It was necessary to employ existing organizations of both contractors and engineers and simply foot the bills, whatever they might be, and it is a high tribute to the honesty, integrity, and ability of both to know—as we do—that, on the

* This discussion (of the paper by Ernest Wilder Clarke, M. Am. Soc. C. E., published in August, 1919, *Proceedings*, and presented at the meeting of September 3d, 1919), is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

† New York City.

‡ Received by the Secretary, September 6th, 1919.

Mr. Lavis.

whole, practically no undue advantage has been taken of this situation by either class and that most of the work has been carried out as efficiently and cheaply as was possible under the circumstances.

This state of affairs, however, is abnormal, and the methods used to meet it are seldom applicable to normal conditions. Usually, every one, from the builder of the smallest house to the greatest capitalist and investor, wants to know pretty closely what the cost is going to be before they start in, and they are almost always willing to let the contractor take the gamble, if there is any. Often, however, he has had sufficient experience to be fairly sure in cases which would be pure gambling to others with less experience.

The author rather emphasizes the fact that, if the contractor has to take chances, he endeavors to cover himself by making an unduly high bid, but, on the competitive basis, this is at least partly controlled by reason of the competition. It is to be noted, however, that modern contracts and specifications for work to be carried out on a unit price basis reduce the chances the contractor has to take to a minimum. Splendid examples of this are the contracts used for the construction of the Catskill Aqueduct, by the Board of Water Supply of the City of New York.

The author points out the difficulties in regard to definitions, etc.; in other words, lack of skill on the part of engineers to describe what they want. Of course, it is true that difficulties do occur in the interpretation of contracts and specifications, no matter how skilfully they may be drawn, but many of these could often be avoided by the exercise of a certain amount of common sense on the part of the interpreters, and, in any event, it is doubtful whether the causes for disagreement are more, or more often evident, in contracts based on unit prices than on the "cost plus" form, provided both are properly drawn and honestly and conscientiously carried out.

Some of the objectionable clauses which cause trouble in connection with unit price contracts, pointed out recently by J. W. Rollins, M. Am. Soc. C. E., are as follows:

(1) Disclaiming responsibility for soundings and other information as to the character of the work.

(2) The insertion of the clause which may make any contractor's estimate and bid worthless, that is, "or as otherwise directed."

(3) Making contractors responsible for work for which the engineers make the plans, or requiring the approval of the engineer to any made by the contractor for temporary work, and in which the engineers reserve the right to control entirely the manner and means of construction.

(4) Holding the contractor responsible for work which has been built under the direction of the engineer, and has passed inspection, unless fraud and gross negligence is proved.

(5) Making the engineer the sole referee in settling all claims. Mr. Lavis.
(6) The right to stop work, or any part of it, if it is to the interest of the engineer so to do, without allowing the contractor any compensation for such action.

The author points to similar clauses as increasing the cost of work carried out on a unit price basis. They do cause such increases, but they are indications of lack of engineering skill and ability, and should have no place in a properly and fairly drawn contract.

In considering the merits of any form of contract, it must be assumed that the same conditions will apply. For instance, it is useless to say that because the owner refuses to make proper sub-surface investigations, the unit price bid is a gamble. Under these conditions, any form of contract is a gamble.

The author thinks the contractor who bids in competition may bid high because of improper estimates of quantities. This is a confession of lack of sufficient engineering, or lack of engineering skill, the results of which can hardly be charged against a form of contract. If similar lack of skill is shown in connection with a "cost plus" contract, the result would be equally disastrous or expensive to the owner, if not more so.

Judging from some paragraphs of the author's paper, one would imagine that all bidders on unit price work were gamblers with the dice loaded in their favor, but the writer is sure that an extended acquaintance with the financial results of their work, year in and year out, would show that they make less net profit perhaps than the majority of men in business who bring to their work an equal amount of skill, intelligence, and really hard work.

One thing must not be lost sight of in connection with "cost plus" contracts, that is, no matter how honest and conscientious the principals are, it is difficult to determine whether the actual output per unit of the men's time is as great on work done on this basis as it is on the lump-sum or unit price basis.

The theory that the engineer in charge of a contract is a referee or arbitrator between the owner and the contractor, the writer thinks will hardly hold in the Courts. As a matter of fact, engineers are so by courtesy, because usually they are held in high esteem by both their employers and contractors, and both, in many cases, are willing to abide by their judgment.

The author believes that with efficient honest contractors and engineers, better results can be obtained under the "cost plus" form of contract because "the owner will not be confronted by bills for extras, vexatious claims for adjustments due to different misinterpretation of the specifications", etc.

Mr. Lavis.

With honest capable contractors, there is seldom much trouble. The author must bear in mind, however, that with the unit price contract all the engineer has to do is to see that the quality of the work is good and that its performance is up to date. With the "cost plus" form, notwithstanding the reputation of the contractor—and with many it is very high—the owner's representative, if he is conscientious, will not only satisfy himself as to the quality of the work, but also of the honesty and efficiency of the contractor's organization. He can no more take for granted that pay-rolls are not padded, that outside commissions are not paid, or that the men or the organization are efficient, than he can take for granted the depth of a foundation, the quality of the soil, or the acceptance of Portland cement or steel without testing.

The author asks the specific question as to the desirability of adopting the "cost plus" form for municipal and other public works. Under war or similar conditions it may be; but, for normal conditions, no. The writer has had some experience and vexation in connection with the red tape, etc., thrown around the letting of municipal or other public works contracts. The award to the lowest bidder is often a cause of expense, but, by and large, and taking into consideration all the facts, it will be found that there are many good reasons for the various regulations and safeguards thrown around the actions of municipal and governmental officers in the expenditure of public funds.

Besides all these things, there is also the important item of predetermination of total cost. Of course this is accomplished to a certain extent in those forms of the "cost plus" contract which name an estimated total cost with a sliding scale fee increased for keeping within the total, and decreased for exceeding it, but there is not the same assurance—which is often desirable—with this form as with others.

It seems hardly feasible to define exactly what kinds of work or what set of conditions warrant the adoption of one or another form of contract, but, in general, the following may be suggested:

a.—For certain forms of work, involving clearly defined materials and easily determined quantities, where important changes are not probable, and where the size of the job is not too large, the lump-sum form of contract is indicated.

b.—For forms of work, where specifications can be drawn, which will define reasonably clearly each class of work to be performed, but where only approximate determinations of quantities can be made, the unit price form is indicated.

c.—When conditions are such that the work to be done cannot be defined reasonably clearly and definitely, or when the period of construction extends over such a long time that it

is difficult to forecast conditions so far ahead, or in a time like the present, when everything is so disturbed, there is little option but to adopt the "cost plus" form. Mr. Lavis.

The writer realizes, of course, that these conditions overlap, and that many others may influence the decision, but, in this, as in everything else, the skilful experienced engineer will realize the conditions, and, being informed as to all the different kinds or forms of contracts, will advise his client accordingly.

Missac Thompson,* Jun. Am. Soc. C. E. (by letter).†—For purposes of this discussion, the writer will classify contracts as long-time and short-time. Without trying to draw a line of demarcation, he will state that the long-time contract is one, the fulfillment of which will take sufficient time to anticipate marked changes in the market prices for labor and materials; whereas, the short-time contract is one, the fulfillment of which will not take sufficient time to make appreciable difference in the market prices of commodities for the particular work. Mr. Thompson.

This division cannot be made in terms of time measure alone, other circumstances, such as the political and economical situation of the country, the particular contractor, and his organization, are also factors to be considered.

Long-time contracts, if based on preliminary designs, are not often drawn on the lump-sum basis. If such contracts are drawn on the basis of item charges, again, both sides are gambling.

It is very difficult, if not impossible, to define what might be acceptable material or workmanship. In such construction as reinforced concrete, with the ordinary method of inspection, the owner or his representative has no practical protection against dishonesty or negligence on the part of the contractor.

It seems to the writer that, in long-time contracts, the interests of both parties—owner and contractor—will be safeguarded, if all the materials forming a permanent part of the job are furnished by the owner, and the contractor simply bids on the actual construction on a labor-day basis for the unit of work.

This mode of contract can be illustrated by an example: Suppose Jones wants to build a reinforced concrete factory, and Smith is the contractor for the job. Jones furnishes all the permanent materials for the work; Smith bids on furnishing the timber for forms and erecting the form work at one-fifth carpenter-day per square foot of form; or, on mixing and placing the concrete at one-half labor-day per cubic yard, etc.

In some cases, the contractor by superior knowledge of market conditions may obtain materials to better advantage. In that event, his services may be made use of and paid for as such.

* New York City.

† Received by the Secretary, September 8th, 1919.

Mr. Thompson.

The owner by furnishing the materials is sure of getting what he wants. He is relieved of rigid inspection obligation, because faulty workmanship will always show. He can get more competition for his job, because much less outlay of capital on the part of the contractor is necessary. In most cases, the owner, with his ready cash, is in a better position to bargain for the materials.

On the other hand, the contractor is relieved of probable rejections, disputes, etc.; he saves time by doing away with a lot of unnecessary checkings, markings, etc.; and he is safeguarded against wage increases, strikes, etc.

In some cases, the same basis may be used for short-time contracts as that suggested for long-time contracts. However, in many cases, this procedure is impractical:

First.—The owner usually finances the work by borrowing from banks or individuals, and the loan cannot be arranged to pay for materials as they are delivered.

Second.—It is more practical for the owner to pay somewhat more and know beforehand the cost of the work, in order to arrange for his financing.

Third.—Very close estimates of materials and labor can be made beforehand, and the contractor's percentage of profit on small jobs is necessarily larger and the elements of uncertainty are less.

Fourth.—Even if bids are taken from preliminary designs and estimates, a clause may be inserted in the contract terms, by which additions and subtractions may be taken care of.

It seems to the writer, therefore, that, for short-time contracts, the lump-sum basis is practical and desirable. However, the "cost plus" definite fee or the cost plus percentage method of contract is objectionable, because it kills competition which is the key to efficiency. It offers undeniable opportunity for favoritism on the part of the owner's representative. Moreover, it is out of the question to persuade most investors, who borrow to finance their enterprise, to let a contract on the cost plus percentage basis.

Mr. Frankland.

F. H. Frankland,* M. Am. Soc. C. E.—The author states that he does not pretend to present arguments either for or against any particular form of contract, but a reading of the paper shows that it is only a brief for the "cost plus" system. In fact, in the author's remarks just preceding the opening of the oral discussion, he admitted that this was true.

Most of the worst features of lump-sum and unit-price contracts are discussed in the paper, whereas nothing objectionable is mentioned as relating to the "cost plus" system. In the speaker's opinion, based on a great many years' experience in the supervision of engineering con-

* New York City.

struction, all the ordinary forms of contract, as exemplified in lump-sum, "cost plus", and unit-price work, have serious drawbacks. Mr. Frankland.

In one place, in his paper, the author makes the serious charge that the engineer is always biased, and no matter how hard he tries to be fair, no matter how cordial the relation between himself and the contractor may be, in case of argument the latter bears the burden of proof. This is a pretty strong statement, and the speaker considers it a somewhat unwarranted aspersion on a large number of engineers, possessed of experience, principle, integrity, and (to use the Shakespearian expression) engineers with "guts", who are absolutely without bias against contractors. Many instances could be cited where supervising engineers have fought hard and successfully for a square deal to a contractor.

The speaker mentions this because it is one of the stock arguments which is always brought up, when "cost plus" contracts are discussed. The war is over, and conditions have changed more suddenly and more completely in a given time than ever before in the recollection of most of the members of the Society, and the present seems to be the psychological moment for the engineers and contractors of the United States to "get busy" and do something about forms and bases of contracts. It is generally admitted that a large amount of foreign engineering and contracting is now open to American engineers and contractors, if they will only go after it in the proper way.

One of the serious disadvantages of the ordinary kind of "cost plus" contract is the lack of incentive for the contractor to complete the work at the lowest legitimate cost. The ideal form of contract should provide for the best possible workmanship at the lowest legitimate cost. The ordinary forms of "cost plus", lump-sum, and unit-price contracts do not fulfill these requirements, and the time has arrived when something should be done toward improving the methods of letting construction contracts now in vogue. It must not be imagined by any one that an ordinary "cost plus" basis for foreign contracts will be acceptable to the owners. This form of contract is rightly looked on abroad with suspicion.

If the whole truth was known regarding some of the "cost plus" contracts let in the United States during the past few years, this form of contract would "smell to high heaven." Of course, we all know that it was absolutely necessary to let a great deal of work during the war on a "cost plus" basis in order to get it done, but to the speaker that does not seem to be a valid excuse for the continuation of that form of contract.

J. Waldo Smith,* M. Am. Soc. C. E.—The speaker is one of those who believe that, under certain conditions, there is a proper use, and Mr. Smith.

* New York City.

Mr. Smith.

even necessity, for each of the forms of contracts outlined by the author, although he does not at all share the opinion as to the desirability of the general use of a "cost plus a percentage" or "cost plus a fixed sum" contract, or the difficulty of carrying out a regular itemized form of contract without including "extra work."

If the plans are so indeterminate and the investigations so incomplete that it is impracticable to form an estimate of the total cost within reasonable limits, then, without doubt, the "cost plus a percentage" contract is the only one which fits the case, especially if great expedition is required. If, however, it is possible to make an estimate of the total cost within reasonable limits, then some form of the "cost plus a fixed sum" contract is entirely practicable and to be preferred to the "cost plus a percentage" contract.

If work was to be done generally by either of these "cost plus" forms of contract, it would certainly lead to the grossest discrimination and favoritism, would prove an insuperable obstacle to the proper development of the contracting business, and tend to destroy the incentive for the study of new methods and the exercise of the greatest resourcefulness in conducting the work. It would also exclude the gambling element which has so strong an attraction for the average contractor.

Under the conditions which have prevailed during the past two years, and the enormous volume of work done without the preparation of detailed plans, where many of the conditions were indeterminate and where great expedition was required, it was undoubtedly necessary to use both the "cost plus a percentage" and some form of "cost plus a fixed sum" contract. In the majority of cases, it is believed that the general type of contract used by the Construction Division of the U. S. Army, of "cost plus a sliding percentage with a limiting sum", or one of its variations on the same principle, was entirely practicable, but there was little need for a "cost plus a fixed percentage" contract.

The author, both in his paper and in his remarks when presenting it before the Society, seemed to have a decided leaning toward a "cost plus" contract for ordinary use. For engineers to advocate such a form for general use is, in the speaker's opinion, a confession of weakness—that engineers are unable to draw contracts and specifications, founded on ample investigations and full information, which are fair to both parties to the contract and on which bidders can make an intelligent and safe proposal.

It is well known that engineers in charge of public work are handicapped in drawing contracts as fair to the parties thereto as they desire, by reason of limitations imposed by the law departments of municipalities or States. These restrictions are largely the result of previous experiences in Court, and the legal authorities seek, by injecting arbitrary clauses into the contract, to prevent recoveries in the future, rather than to make the contract so fair between the

parties to it, that there would be in general no incentive to bring action thereafter. Mr. Smith.

The engineer is often confronted, in the preparation of plans, with a great cry from principals, who may be either private individuals or public officials, to see the actual construction work started before the necessary investigations have been completed. Nothing is more vicious or sure to lead to trouble afterward.

If the contractor is not given sufficient information, if the known difficulties are not set forth, if the proper investigations have not been made by those who have been on the job for months, if it is not clearly stated just what is to be done under each item and how payment is to be made, and if everything reasonable is not done so that the contractor can size up accurately the conditions with which he will probably be confronted, and submit an intelligent bid, trouble is almost certain to develop during the progress of the work and cause litigation afterward. If, however, all this information has been obtained and spread before him, and he is given a fair show and not treated arbitrarily, not only would he fail to collect much through the Court in case of litigation, but the average contractor would not even bring legal action.

Edward F. Hammel,* Jun. Am. Soc. C. E.—The technical press has been devoting a great deal of time and space to this subject of contracts, and all engineers have had various experiences with the matter of contract forms. The speaker will limit his remarks on the subject very largely to building work, to which his experience has been confined. Mr. Hammel.

The speaker asked four contractors to bid on a certain job, and of these, three wanted the work on a "cost plus" basis. Since the owner wanted to know how much the job was going to cost, this form of contract could not be considered. This owner knows how much he can reasonably get for the floor space of the building which he proposes to erect; he also knows about what his taxes and operating costs will be, and, in the light of these facts, he knows about how much he can spend on the erection of the building and still obtain a fair return on the investment. If he cannot get enough interest on the investment he proposes to make, he will not feel warranted in going ahead with the operation. Finally, one of the contractors returned the plans and specifications, stating that, due to the present unsettled conditions of labor, he was unable to undertake the work on any other basis. After arguing on the merits of the "cost plus" contract, the other two finally agreed to furnish lump-sum bids, but stated that ultimately it would cost the owner more than on the "cost plus" basis, because they would have to add a large figure for contingencies, which might be avoided if they went ahead on a cost plus a fixed fee or a cost plus a percentage basis.

It seems to the speaker that the various forms of contracts which have been drawn, have been designed to fit special conditions, and as

* New York City.

Mr. Hammel.

long as the labor market was fairly stable and wage agreements were adhered to by labor—there have been agreements in the past, which have lasted a certain time—and as long as the prices of materials were stable, there seemed to be no particular reason why a contractor could not submit an estimate on the lump-sum basis and finish the job with a reasonable amount of profit. Certain contingencies might arise which would reduce that profit, and others which would increase it, but the contractor was reasonably sure of finishing the job with his overhead covered and a certain amount of profit.

During the war period, conditions were entirely different. The Government speeded up its work, because the buildings had to be erected almost immediately. If they had been erected a year later, they would not have contributed anything toward winning the war. The Government officials were not able to make exhaustive investigations; they did not have the data, nor the time to get them, and it was absolutely essential that some form of contract should be adopted, which was fair to the contractors, otherwise they would not have taken the work. The only way out of it, apparently, was to tell the contractor to build the necessary structures, etc., on some form of "cost plus" contract. The Government chose contractors who had organizations large enough to do the work on a speedy basis, and said: "We will pay you for the cost of the work and for your services", and it seems that the "cost plus" contract was the only form which could have been adopted to meet the emergency.

Addressing a man who was on the contractor's staff on one of the cantonment jobs, and who spent a good part of his time riding to and from the city in an automobile, the speaker said, "You must be making a lot of money". To which he replied, "Oh, no, the Government is paying for this". That, perhaps, was a little item, financially, but it was an indication of the wastefulness practiced on "cost plus" jobs. At times, something has to be sacrificed, and the Government made the sacrifice of money in order to obtain speed.

It may sometimes happen that the owner of a manufacturing plant, such as an automobile factory, may want to extend that plant. He is very anxious to get his addition completed, and he does not care if it costs 10% more than the possible lowest cost, provided he can get it done speedily; therefore, it may seem to him that the "cost plus" is a fairer contract, and, perhaps, it is under these special circumstances. He is willing to sacrifice a financial saving in order to have the building put up more speedily.

On the other hand, a man who is contemplating building on a certain lot, and investing a certain amount of money as an economical investment, can afford to wait a little longer and have his building put up in accordance with a complete set of plans and specifications.

Mr. Hammel.

It seems to the speaker that the advocates of the "cost plus" contract miss certain points. They state that for the contractor it is the only fair method; that building contracting is a gamble; that it is so much of a gamble that the owner ought not to expect the contractor to make a fixed bid; and that he (the owner) ought to take a chance on a "cost plus" contract.

There is no more of a gamble in contracting within certain limitations, than in any other field of business. If the men engaged in the building business were generally to adopt the "cost plus" form of contract, an era of uncertainty would be reached in the cost of buildings, which would greatly restrict construction operations.

The gamble, as the speaker sees it—possibly he may be wrong—is almost entirely related to labor costs. There is no reason why the architect or engineer cannot prepare a complete set of plans and specifications and cover every item. There is no reason why an engineer or quantity surveyor cannot study these plans and specifications and take off accurately the quantities of materials which will be necessary to complete the structure, as accurately, or more so, than the engineer can compute his loads and stresses; and there is no reason why the contractor cannot take this as a basis on which to compute his construction costs. Then all the contractors will be bidding on the same quantities, and not on quantities which may vary greatly, due to erroneous estimations by their own staffs. They will all use the quantities prepared in the engineer's office, and the only thing that will vary is the cost of the labor necessary to put those quantities in place.

It seems to the speaker that some basis of adjustment, due to changes in labor wage scales, can be made. Let the contractor figure on the current labor prices at the time he is making his estimate. He can order his building materials and cover himself on this cost for some time in advance. Future contingencies as to labor costs might be met by an additional stipulation in the contract; for instance, if a provision was put in the contract that if the cost of labor is increased, or if the present or prevailing rates are increased by circumstances not within the control of the contractor, the owner agrees to stand all, or perhaps a part, of such increase, so that the contractor would not lose much on that score, and the owner would be paying only for what he gets.

Then, there is the matter of incentive. As a matter of fact, the speaker knows of some jobs where the lump-sum is favored at the expense of the "cost plus" job. If a contractor is handling three or four jobs, and one happens to be on a "cost plus" or percentage basis, and the others happen to be on the lump-sum basis, and he has any bricklayers who are able to lay more bricks than others, he will keep his good men on the lump-sum jobs and send the "cripples to the hospital"; that is what these "cost-plus" jobs have been called. Three or four men

Mr. Hammel.

get on the end of a rope, and somebody asks, "What are you doing there?" and finds out that all they are doing is holding the end of the rope; that is the way it goes on the "cost plus" job; there is no incentive to reduce costs. On the lump-sum job, however, the incentive to the builder is to get his work done at as low a cost as possible; he is not going to let his men loaf.

To be consistent the "cost plus" contractor should let his sub-contracting work on the "cost plus" basis, but he does not do that. On the average every building contract has a general contractor and, perhaps, 15 or 20 sub-contractors, say, there are 15. The general contractor will often handle his own masonry and carpenter work. The speaker asked one of these contractors who was arguing that it was not fair to ask him to bid on a lump-sum basis, "How do you do with your sub-contractors? How about these fellows? How much work do you do yourself?" He replied, "We do 30% of this ourselves." Frequently, however, they do not do more than 20% of it. The speaker then said to this contractor, "Of course, you work on a percentage basis with all your subs?" He replied, "Oh, no." The contractor will not show that element of fairness to the "subs" which he asks the owner to show to him. He would be willing to tie every one of the sub-contractors down to a lump-sum contract, and whether or not they were losing money, he would hold them to the letter of these contracts. If they are losing money, he says, "If you won't finish up under this figure, the surety company has got to make good on it", while he himself is safeguarded against any possible loss. If the "cost plus" contract is to be adopted, it ought to benefit more than the general contractor who is often a looker-on in this game; it ought to be parceled out to every sub-contractor on the job.

There is one other thing: If we carry this form of contract to its ultimate conclusion, who is going to get all these percentage jobs? There are certain contractors who have no organizations, and they depend on those who have to build the work, to get it out at a lower cost than their competitors; and they often get jobs on that basis without having the organization to complete them. If this lump-sum type of contract that is so unfair, is abolished and the "cost plus" or percentage contract is universally established, who is going to get these nice "soft" jobs? The "inside" man is the one who will be favored. An owner is not going to ask half a dozen contractors to bid as on a "cost plus" job. He is going to pick one man and engage him to handle the matter. The result will be that all the contractors who could go in on a competitive basis to get the business, simply will not know of the work or the owner. Gradually, they will disappear, and after awhile only a few of these favored contractors will be left, who will be making all the money. If a competent young engineer with a little money, some practical experience, and a lot of ambition, wants to

get into the game, there will not be any use of his attempting to do so, because he will be "squeezed" out. He may be a good competent man and have a lot of push, but he will not get anywhere. He cannot go out on the basis of merit and get a job; he will have to "know" somebody in order to be favored. His early years must be spent in making acquaintances. Mr. Hammel.

It seems to the speaker that, after all, under the "cost plus" contract, the contractor ceases to function as a business man. He becomes, not a man who has to use his shrewdness, his executive ability, and his brains to maintain an efficient organization and keep its operation within a reasonable cost, but simply a supervisor of labor, a superintendent of construction, and a material purchaser, and, as such, is very highly paid. All he has to do is to see that the other fellows do their work. He parcels out the work to others and looks it over. He will have degenerated from his present position. Sooner or later, he will be found out, and then he will be found out of a job, for there is no reason why the engineer cannot supplant him. He can sublet what work he wants to, purchase the materials, and supervise the construction for his client; he can add that much to his fee, and then, perhaps, engineers will be able to make a reasonable living.

Lazarus White,* Assoc. M. Am. Soc. C. E.—The speaker believes that engineers have an idea that all contractors are in favor of the "cost plus" form, because it makes an easy and safe job for them. He believes that this paper, as he reads it, advocates the "cost plus" system, at least it gives arguments in favor of it, and arguments against other forms of contracts. Mr. White.

The speaker has had experience both as an engineer and a contractor, and this experience has led him to believe that the old form of letting contracts on a competitive basis is much the best. The great objection to the "cost plus" contract is the means of getting it. There is a moral question which outweighs the question of cost. If the public in the long run is getting something that is not right, they are the ones who suffer. There is something straightforward in letting a contract on a competitive basis, if the job is properly prepared, say, like the contracts of the Board of Water Supply of the City of New York, and the contractors are invited to bid.

They form their own opinions as to what it is going to cost them; they put up a bond; the man who is low is taking some chance, and if the owners have not a very good reason for turning him down, he ought to get the job. Suppose the Board of Water Supply, through its chief, wanted to get a man on a "cost plus" basis. How would he do it? The speaker believes he would not know how to do it. The usual way would be to have a lot of people running around telling what great men they were, that they had the organization, etc.

* New York City.

Mr. White.

When a man gets a job, he intends to make the best showing possible. What kind of work will he get from subordinates? How long does it take them to realize that they are on a "cost plus" basis? Every superintendent is met by this question, "It is not coming out of your pocket, is it?" And the same argument comes from laboring men.

A contractor on a "cost plus" job is not a contractor, he is an accountant; and nine-tenths of his time is given to demonstrating that he paid right prices for everything that he bought, and accounting for every cent expended; and that is the principal thing. It is not a question of efficiency any more; that is swallowed up. There is ten times more accounting on a $1 000 000 contract at "cost plus" than there would be on the same $1 000 000 of straight contracting.

Besides it eliminates the gamble. If a man takes a $1 000 000 contract (it is attractive, it must be said), he may make $100 000. In an ordinary contract, with good management, but on a "cost plus" basis, he is a few thousand dollars ahead of the job at the end of a year's hard work trying to demonstrate that he is not a crook.

There is another inherent difficulty: If the "cost plus" was carried to its logical conclusion, nobody would know what anything would cost, because certainly the total would be the sum of a number of "cost plus" jobs; and what would that total be? It seems that, on public work, in the long run, the "cost plus" contract could not be tolerated, because public work is done against definite appropriation on a "cost plus" job. When a city lets a job for $1 000 000, it is committed to $1 000 000. When it lets a job on a "cost plus" no one knows to what it is committed. The same thing applies to the individual.

The speaker is simply giving his experience as an engineer and a contractor with both styles of construction.

Mr. Davis.

ARTHUR P. DAVIS,* M. AM. SOC. C. E.—The form of contract suggested by J. A. L. Waddell, M. Am. Soc. C. E.,† is excellent, if it can be carried out, but its use requires that all details be thoroughly well known in advance.

Now, those who have had experience on very large jobs, realize that it is very difficult in all such jobs to know the details in advance, and it is absolutely impossible in others. For instance, how is any contractor going to know all the details of a job on a foundation that has to be put down 100 or 150 ft. below the level of the ground, until it is actually opened and dug out. He can do all the boring, and all the guessing, he pleases, and yet he does not know how it is going until it is open. Such work always involves a big element of risk, as does also every long tunnel that passes through a high mountain. However closely it may be examined, there is a large element of uncer-

* Washington, D. C.

† *Contracting*, September 15th, 1919, p. 178.

tainty in the conditions that are to be encountered by a contractor who takes such work on any kind of a basis except a "cost plus" basis. Mr. Davis.

The term, "cost plus", is very indefinite. There are two radically different methods of "cost plus" contracts. One is to pay the cost plus a percentage and the other is to pay the cost plus some fixed sum. They are radically different, as different as the east is from the west. The speaker recognizes the fact that there were conditions at the breaking out of the war, which had to be met by rather unusual methods; but he has talked with both engineers and contractors who were engaged in the "cost plus" work, and has yet to find one who could convince him that it was not possible to have let those contracts on some other basis than to place a premium on extravagance and waste. In other words, to find out closely enough so that some fixed sum could be named as compensation for the use of the contractor's skill, equipment, and organization; or, still better, that some method could not have been outlined by which he could have received just compensation, and, in addition, a reward for properly ascertained economies—economies both of time and of money.

If a contract is let on the basis of cost plus a fixed sum, the contractor will earn his fixed sum sooner if he rushes his contract through and closes it up in a short time, which is the great consideration in the case of preparation for war. Deliberately, that incentive was taken away from the contractor.

We regard the great judges of our all-powerful Courts among our highest-class public officials. They should be, and usually are, selected, with great care; men who are just, who have an incentive higher than personal gain, as far as human beings can be found who do; and yet we find it to be a universal rule in all the Courts, from the highest to the lowest, that a judge shall not be permitted to sit in judgment in a case in which he is interested, because it is humanly impossible for him to eliminate his personal interest from his actions and his determinations.

Now, that is just as true of contractors as it is of judges. Even the contractor's own subordinates, his own employes, know that he has interests a certain way; that it is to his interest to make it cost more, because in that case he gets a larger fee; and temptations are such that it is absolutely necessary to guard against contracts of that kind. Assuming, however, that those who know more about the circumstances than the speaker, are right, that the "cost plus" contract was unavoidable in the haste of preparations for war; let us not lend any influence to extend that pernicious practice in ordinary work. Let us find out what the work should cost, as nearly as possible, and where it can be determined well in advance, the unit price contract, with fairly drawn specifications, is, as far as the speaker's experience goes, the fairest of all methods.

Mr. Davis.

In that case, engineers have the opportunity of reasonable changes without affecting materially the profits of the contractor, if he has made a well-balanced bid; and in the case of earth-work, at least, and many other kinds of work, it is impossible to tell in advance how each of the units is going to run. A classification will be carried on as the work progresses, and the different classes put on a unit basis, so that the errors of estimate in advance will not greatly affect the profits, because where the material is harder, it commands a higher price for a higher classification.

It is at least logical and practicable, and is likely to make it to the interest of every man connected with a piece of work, to do the work right, and do it economically; and let us not assume that people are superhuman, and do not, and will not, look to their interests in getting out their work.

Where work is of such uncertain outcome, or is likely to involve many changes or much hazard, a contract let on a cost basis with compensation to the contractor, to be paid after a manner similar to that suggested by Mr. Waddell, is the best solution, even if the uncertainties leave more uncertainty as to the contractor's compensation, which is not nearly as bad as to leave him with a possibility of heavy loss, or to offer him a substantial premium for extravagance and waste.

Mr. Quimby.

HENRY H. QUIMBY,* M. AM. SOC. C. E.—A large proportion of construction contract work is done for the public—the owner is the public, either Municipal, State, or National—and, in such work, competition is essential. Is there a practical and satisfactory scheme for securing competing bids on a "cost plus" basis? A limit of expenditure in every such contract is also essential, and as the limit must be fixed before the contract is delivered, and, therefore, before the work is done, an under-estimate might cause the serious embarrassment of reaching the limit before the completion of the necessary work.

"Cost plus", whether it is plus a percentage or plus a lump sum fixed or variable, sounds fair, and if by it the owner gets just what he pays for, it is fair; but we must conclude from what we see and hear that that result is not commonly secured. If the contractor's compensation increases directly with the cost of the work, the system puts a premium on extravagance, as Mr. Davis has stated. It certainly may operate to eliminate all ambition on the part of the contractor to show his superior skill and efficiency as such, even if it does not induce him to nurse the job.

Only a few days ago, a division engineer complained to the speaker of the slow progress being made on the force account portion of a certain contract, and declared that he always noted a marked difference between the spirit in which the percentage portion of the contract was done and that in which the work was performed on the fixed-

* Philadelphia, Pa.

price portion by the same men. When it was suggested that the men need not know that the work is on a separate account, he replied that the men always know, and invariably produce less. Mr. Quimby.

The sliding scale of compensation based on the relation of the actual total cost to a guaranteed maximum sounds logical, as tending to induce effort and promote efficiency, but a guaranteed maximum cost to the owner necessarily involves a risk of loss to the contractor, to avoid which is one of the arguments for the "cost plus" idea. Also, in case competition for the contract is necessary—as for public work—the sliding scale for compensation would have to be prescribed in the specifications, and the bidding would have to be on the guaranteed maximum, the temptation to take chances by a bidder being, therefore, much the same as in straight lump-sum contracting.

As the guaranteeing of a maximum cost will require the bidder to make a careful estimate, the plans must be definite as to the extent of the work and as complete as for a straight lump-sum bid, and this requirement eliminates one of the principal arguments for the "cost plus" contract.

If the bidder must take a risk by guaranteeing a maximum sum, why should he not have all he can save out of it; and if he must share such savings with the owner, why should not the owner share any loss that may result through an excess of actual cost?

In "cost plus" work, the necessity for checking the contractor's costs involves not only the additional cost of services, which may be quite appreciable, but is likely to occasion disputes and develop unpleasant inquisitorial procedure, leading to direct supervision by the owner's representative of all the operations under the contract—purchase of material and direction of work—a situation under which a real contractor will not be happy, and which, pursued logically, will tend to dispense with his services. In the Graff system, described in "Bridge Engineering", the contractor stipulates that he "be left absolutely untrammeled and allowed to enter the buying market and otherwise to conduct his operations as though he were executing a straight contract."

There is a form of contract which, although giving the contractor an opportunity to develop his best methods of operation and win both the contract and a profit on it by his skill and energy, provides reasonably for both changes in plans and some kinds of contingencies. This is a lump-sum contract for the definite construction shown by the plans, together with unit prices for the various classes of work and material involved, these prices being applicable to changes in quantities—in full to additions and a reduced amount, say, one-half, to deductions. For any class of work not covered by such unit prices, a force-account item is also provided, the percentage to be bid in the proposal the same as the other prices. An aggregate of a bid for comparison of bids is obtained by extending the unit prices and force-

Mr. Quimby.

account percentage on assumed quantities, and adding the extensions to the lump-sum bid for the work shown; thereby competition is secured throughout. In the event of changes being desired, which the unit prices do not specifically cover, or which create conditions not contemplated and make the bid price unfair, or, in case obstacles are encountered for which the contractor has not assumed responsibility, a special dicker is necessary, and, in such a dicker, the party of the second part to the contract is ordinarily quite as potent as the party of the first part.

The plans ought to be as complete as possible before the contract is made, and if an owner is not so prepared and goes ahead on meager data, he must expect to pay more in one way or another. If the plans can be made definite, so that quantities can be determined and under-surface conditions be reasonably explored, the greatest satisfaction to the owner, engineer, and contractor will generally be secured by a lump-sum contract or a fixed unit price contract with equitable provision for adjustments.

Mr. Perry.

J. P. H. PERRY,* M. AM. SOC. C. E.—The impression gained by the speaker from the discussion on this subject, seems to be a fairly common one, namely, that the cost of work, that is, the unit cost under the "cost plus" form of contract, is higher than for similar work done under a lump-sum or straight contract basis.

The Turner Construction Company, of New York City, of which the speaker is a Vice-President, has had an experience which would contradict that impression. The Company is in the building business and has erected nearly 600 reinforced concrete factory, warehouse, and other industrial buildings since May, 1902. On this work it has been found consistently that lower unit costs have been obtained on jobs done on a "cost plus" basis than on those for which the contract was a lump-sum or straight contract. Of nearly 750 contracts which have been handled to date, the division between the lump-sum and "cost plus" types of agreement has been nearly "fifty-fifty."

At the request of the editors of *Engineering News-Record*, in the spring of 1919, the Company investigated its cost records to see what conclusions could be drawn from cold facts and figures as to the effect of the type of contract, that is, lump-sum or "cost plus," on unit costs of building work. In order to get the comparison, the Company had to go back to 1917.

During this year, it built 22 factories or warehouses of reinforced concrete, on each of which the contract exceeded $100 000. The average for each of the 22 jobs was $413 000, which makes each building a fair-sized building contract. Of these 22 buildings, 13 (averaging $470 000 each) were built under a "cost plus" form of contract and 9 (averaging $329 000 each) were built under a lump-sum contract.

* New York City.

Mr. Perry.

By a remarkable series of coincidences, the buildings that were "cost plus" or lump-sum parallel one another in the outstanding features, which, on a critical examination of the cost records, might be thought to affect the costs. That is, for every "cost plus" job, the Company had another, generally similar in size and location, under a lump-sum contract. Similarly, for every beam and girder "cost plus" job, there was a beam and girder job on lump-sum, and, in the same way, flat slab jobs, brick veneer jobs, and in-town and out-of-town jobs matched up fairly well.

It has been the Company's experience that, for purposes of comparison of the cost of buildings, three labor units and a general expense item taken together serve as a very accurate criterion as to the relative cost of the complete building. These are, as itemized on the Company's accounting system:

Item 3-F.—This item includes the cost of carpenter and labor work per square foot of floor required for placing and removing floor forms, including all hoisting and miscellaneous work in connection therewith. This item does not include the cost of making the forms before they are used for the first time and, therefore, a comparison is possible as between buildings having a different number of stories.

Item 22.—The cost of labor per cubic yard for all work in connection with the mixing and placing of concrete is included in this item. An average of this unit will give a very fair comparison.

Item 30.—The cost of all labor per ton for receiving, handling, bending, and placing steel reinforcement is kept under this account. As the labor conditions under which this work is done, differ in the metropolitan districts from conditions existing outside of these districts, one comparison is made between jobs in the metropolitan districts and another between jobs outside of such districts.

Item 19.—This includes the general expense expressed as a percentage of the total pay-roll for the job. This item is included to show that the units obtained on Items 3-F, 22, and 30, were not influenced by incorrect charging of labor to general Item 19, thereby reducing the amounts properly chargeable to the cost of forms and the placing of concrete and steel.

The figures on these items for the jobs in question are shown in Table 1 which should be self-explanatory.

The speaker would like to call attention to certain factors back of the figures quoted in Table 1.

Placing and Removing Floor Forms.—There is some difference in the cost per square foot for Item 3-F, as between flat slab and beam and girder construction. By a coincidence, it happens that 14% of the floor area in the percentage jobs was beam and girder and 86% was flat slab, while, in the lump-sum jobs, 13% was beam and girder and 87% was flat slab. Because of this similarity, the comparison made

Mr. Perry.

TABLE 1.—COMPARISON BASED ON A STUDY OF COST UNITS ON ALL FACTORIES AND WAREHOUSES COSTING MORE THAN $100 000 BUILT BY TURNER CONSTRUCTION COMPANY IN 1917. Total Number, 22.

	Average unit on 13 percentage jobs.	Average unit on 9 lump-sum jobs.	Percentage jobs were cheaper by:	Lump sum jobs were cheaper by:
Item 3-F: Cost per square foot of placing and removing floor forms	5.75c.	6.25c.	8%	.....
Item 22: Cost per cubic yard of mixing and placing concrete	$1.02	$1.04	2%	.....
Item 30: Cost per ton of receiving, bending, fabricating, and placing steel reinforcement on jobs in the metropolitan districts	(10 jobs) $15.71	(4 jobs) $14.89	.....	5%
Item 30: Cost per ton of receiving, bending, fabricating, and placing steel reinforcement on jobs outside of the metropolitan districts	(3 jobs) $9.01	(5 jobs) $8.87	.....	2%
Item 19: General expense. The amount charged to this miscellaneous item is expressed as a percentage of the total pay-roll.	1.8%	2.3%	.....	.....

between the average units on the percentage work and on the lump-sum work is not influenced by any difference due to the slightly greater cost of beam and girder forms over flat slab forms. The column spacing was sufficiently similar in all the buildings, so that any difference due to this element may be disregarded. Item 3-F has a tendency to be lower in buildings having a greater number of stories, because the 3-F unit for the first floor is nearly always higher than the same units for the floors above that. As all the buildings studied are five or more stories in height, with the exception of two, which are four stories, the influence of the element of height is very slight. It is to be noted that the next to the lowest 3-F unit obtained on any of the 22 buildings was at Becker's Aniline and Chemical Building, which is only five stories high, and each of the units made on the two four-story jobs are below the average. It is believed that a comparison of the 3-F unit, as between the percentage group of jobs and the lump-sum group, is a fair one and means that, if anything, the organizations on the percentage "had the jump" on those on the lump-sum job for this item.

Mixing and Placing Concrete.—With equal efficiency on the two classes of construction, the averages of Item 22 should run very closely together, and such is the case, the difference being only 2%, in favor of the percentage organizations.

Mr. Perry.

Receiving, Bending, Fabricating, and Placing Steel Reinforcement in Metropolitan Districts.—The lump-sum jobs exceeded the percentage jobs by 5%, and this difference is probably justified by the more difficult conditions affecting this Item 30, which existed on the percentage group of buildings.

Receiving, Bending, Fabricating, and Placing Steel Reinforcement on Jobs Outside of Metropolitan Districts.—The lump-sum jobs exceeded the percentage jobs by 2 per cent. The comparison is a fair one and should be a true indication of efficiency.

General Expense.—The amount of money covered by the classification in Item 19 is very small compared with the other items used in Table 1. The only reason for tabulating the item was to show by its smallness that improper charges had not been made to it, thereby reducing the charges of pay-roll made to Items 3-F, 22, and 30.

To some of the discussors, the results of this investigation made by the speaker's Company will sound like anarchy, but there is a sound reason back of these figures. It has been the experience of the Company that under a "cost plus" form of contract, there exists essentially a partnership between the owners and the contractor. There is only one interest, namely, to give the best work for the least money in the quickest time. If the contractor expects to continue in business, he has to earn the confidence and commendation of that particular owner. To lump-sum contractors there seems to be, in some cases, a different interest. Each side wants to be sure that the other side does not get the advantage under an agreed price.

Under "cost plus" contracts, the contractor feels free to go to the owner with suggestions for modified ways of doing the work, and for the substitution of methods or materials; and likewise the owner is more apt to give favorable consideration to the contractor's suggestions and to offer his co-operation and assistance in such matters as steam, light, power, railroad siding, supplies, purchasing, housing, and the like. Under a lump-sum contract, if the contractor comes to the owner with suggestions or requests, the owner is liable to say, "You have your lump-sum contract. Why should I help you out? I have no more interest than to see that I get what I want."

If, as is the case in nineteen out of twenty building contracts, changes, alterations, or additions are made in the work to be done after the contract is signed, the owner is at the mercy of the contractor on a lump-sum contract. We all know how difficult it is to put a contractor off the job, and how unusual it is to get another contractor to come in and do extra work when the first contractor is still on the job.

A friend of the speaker, a distinguished New England contractor, in the same line of business, puts this whole question in another, but particularly practical, way. His statement, as recalled, was to the

Mr. Perry.

effect that he would like to see a comparison or a statement of the difference between the total cost paid by the owner for a given piece of work under a lump-sum contract when all extras had been paid for, and the cost of a similar piece of work done on a straight cost plus fee contract. It was his judgment that the average lump-sum contract plus extras, would cost the owner more than the "cost plus" or service form of contract.

The speaker would like to say just one word as to the recent vigorous condemnation of "cost plus" contracts. The question would seem to be not so much one of different types of contract as one of conditions under which work was done. It is hard to see any valid reason why labor should be less efficient on a percentage job than on a lump-sum job. A workman is naturally primarily interested in his own welfare and, therefore, in the keeping of his job. If negligence and a lack of interest in his work lead to his discharge on a percentage job just as quickly as on the lump-sum job, while he finds that diligence on the percentage job is awarded by advancement and continuous employment by the contractor, he will work just as hard on one form of contract as on another. The whole thing really comes down to the disposition, intent, and organization of the contractor.

There has been a pretty wide disposition to discredit "cost plus" contractors for the Government during the war and to blame the high costs of Army work on the "cost plus" contract. The speaker feels that this is wrong. In the majority of cases the jobs were in out-of-the-way places, where it was extremely difficult to obtain labor, also at a time when there was a great demand for labor. Furthermore, the speaker feels that the war costs, high as they are known to be, resulted not only from the conditions mentioned, but also because of the inexperience of the workmen. The experienced workman in most lines of industry continued to give good services during the war when working for his old employer, but there were not nearly enough of these experienced workmen to carry on the Government building programme, and it was, therefore, necessary to employ large numbers of men new to the industry. These men were frequently found to be inefficient.

At present, the speaker's Company is erecting more than 50 buildings, practically all on a "cost plus" basis, and generally apparently to the owners' satisfaction. The owners on more than 200 other buildings, which the Company has built on "cost plus" contracts, seem to be satisfied with the costs, time, and quality of the work which they got. This is indicated by the surprisingly large number of repeat orders for buildings from "cost plus" clients. As a matter of fact, of a total volume of nearly $50 000 000 of private business, 72.2% has been on a repeat-order basis. This would seem to be a pretty good answer to the objections to "cost plus" contracts for private industrial business.

Mr. Perry.

The Company kept a cost system regardless of the type of contract. The jobs are divided into some fifty odd accounting units, that is, detailed cost units, very much on the basis of manufacturing shop costs. The units under discussion are the pure net units without any respect to profit, overhead, insurance, or other general job or main office top charges. The costs quoted for lump-sum contracts are the net costs to the contractor. The contract price does not enter into the question. It is just as though one took the shop cost of making a wheel. This cost of that wheel would be presumably without any overhead expense; it would be merely the labor that went into the wheel, as distinct from the materials or the selling price. The Company sought to arrive at the unit costs.

To do building work economically, expeditiously, and well, in reinforced concrete, requires skill and complete organization and experience. Only contractors who can get work on a reasonable basis of compensation can retain organizations of this type. Many contractors can go in and gamble on their profits on a "hire-and-fire" basis, but the conservatively organized concern prefers not to take a chance on losing money, but to take only such work as gives a reasonable profit.

The figures quoted do not include the contractor's profit. They are merely unit costs or shop costs aside from insurance. The results, although for 1917 only, check very closely with 17 years' experience on more than 500 buildings. The Company has known for years that it got lower costs for the owner under a "cost plus" contract than it could for its own pocket-book on a lump-sum contract.

In reply to the question as to what is meant by "cost plus," whether it is cost plus percentage or cost plus a lump sum, the speaker would say that the 22 buildings under discussion were about equally divided, on the one hand, between the cost plus straight percentage on a sliding scale where the contractor's compensation varied directly as the cost of the work, and, on the other hand, a cost plus a fixed fee or lump sum, where the contractor's compensation was independent of the cost of the work. Some of these contracts had guaranteed totals with or without profit-sharing. There are many different ways of writing "cost plus" contracts; any one can sit down and work out twenty or more of them in an afternoon, but it is a fact that the best units, that is, the best net units of the cost of the work, have been made on unguaranteed jobs, and the reason for this is the spirit of confidence and cooperation which usually cannot be gotten from the owner under a lump-sum form of contract.

In regard to whether or not the lower cost of the "cost plus" contract in the speaker's organization was reflected in the amount that the owner had to pay for the job, or whether the Company made more money out of it, the speaker would say that if the contract was a

Mr. Perry.

straight unguaranteed cost plus percentage form, the cost paid by the owner is the net cost plus the fee, so that any variation in cost benefits the owner directly. If the contract has a guaranty or upset price, it usually also requires a profit-sharing clause, so that any lowering of unit net costs would benefit both the owner and the contractor. This profit sharing varies from one-half to one-third to the contractor and two-thirds to the owner. Occasionally, the owner's share is even higher.

On some of the Company's contracts it has profit-sharing, but not on a lump-sum contract. In this latter type, the contractor makes all the profits on any unexpended allowance that there may be. A "cost plus" contract with a guaranteed total is really an attempt on the owner's part to "eat his cake and keep it too." It is a cumbersome contract, because it is subject to all the careful estimating and bargaining on extras and credits that the lump-sum contract effects, and, at the same time, requires the minute cost keeping and negotiations with the owner which a "cost plus" job involves.

On every job the Company has, its superintendents' profit-sharing plan applies. In explanation of that plan, it may be stated that ever since 1910, the Company has been saying to its construction organizations that if they equal or come inside of an agreed estimate, the superintendent, and on big jobs, his chief assistants, will get extra compensation or bonuses, varying by the amount that the estimate is exceeded. Recently, this plan has been extended to include the principal foremen on every job. The speaker has mentioned an agreed estimate, and by this, he means that, on cost plus fee jobs, the estimate is submitted to the architect or engineer and the owner for their approval as a reasonable amount to allow for the work in the immediate control of the job organization. On lump-sum contracts, the estimate is not submitted to the architect, engineer, or owner. It has, however, on either kind of contract, to pass the profit-sharing committee of the Company.

On "cost plus" work the owner is told that any bonus earned under this plan is part of the cost of the work payable by him, because such bonus or extra compensation is, in a measure, extra salaries paid to the organization in order to get lower costs, and the owner benefits equally.

The statement has been frequently made that on "cost plus" work the men actually doing the work in the field know the character of contract, and the pocket of the disbursing agent, be it the Government or a private owner, suffers accordingly. The experience of the speaker's Company contradicts this, and it is believed that that experience has been sufficiently wide to make its opinion of fair value. As stated, the whole question is one of the spirit of the organization. If it is known throughout the rank and file of a contracting organization that a man is discharged just as quickly for careless shirking work

or inefficiency on a "cost plus" job as he is on a lump-sum job, experience indicates that no difference can be detected in the unit costs between a "cost plus" or a lump-sum job. Unit costs really tell the story of the relative operation of the two contracts. Mr. Perry.

If there is efficient management, systematized inspection, and a determination to see that an organization is run on an even keel, regardless of the form of the contract, any difference in the unit cost on a job due to the form of contract would be in general in favor of the "cost plus" job.

Relative to the closeness of the two forms of contract in their comparative costs being due to the fact that the superintendents and the foremen shared in the profits, the speaker thinks that undoubtedly that is true, but it seems to him that if this point is admitted, it might be also admitted that the form of contract really makes no difference at all. The speaker recently made up some figures showing the difference between the estimates given by his Company to owners at the time of negotiating the contracts for their work and the actual costs which the same owners paid for the completed undertaking. These figures cover all "cost plus" contracts made between July, 1910, and January 1st, 1918, that is, about $7\frac{1}{2}$ years, and cover about $12 500 000 worth of work. The actual cost paid by the owners, including all profits to the contractor and any bonuses to field organizations of the contractor, were less than the estimated costs by about $400 000, or approximately 3 per cent. This covers a total of about 90 contracts for probably 115 buildings.

It would seem that this was a pretty good indication of the excellence of the management, the ability to estimate correctly the costs, and the consistent performance of the field organizations in carrying out the schedules set up for them. It checks back again to the proposition that the type of contract is not the determinate factor. The really important feature is the management and, perhaps, the intent and disposition of the contractor.

HENRY B. SEAMAN,* M. AM. SOC. C. E.—In the discussion of this paper, reference has been made to Government work or, more properly speaking, to war work, and the apparently excessive cost of the "cost plus" contracts for the Government during the war. The cost of war work should never be compared with similar conditions on private work, as the cost of work for war purposes was of minor importance when compared with the time to be saved in its completion. There was an "enemy at the door", and an extra cost of, say, $1 000 000, on a large piece of work, was not to be compared with the possible saving of 2 weeks' time in its completion; not only were many lives in jeopardy, but victory itself was at stake. Mr. Seaman.

* New York City.

Mr. Seaman.

At the beginning of the war, there was no time to enter into formal contracts. Contracts amounting to millions of dollars were awarded verbally, the terms to be confirmed in writing later, and the increasing number of contracts continually awarded gave no opportunity for details.

In due time, the various forms of contracts were fully considered by a board representing six different branches of the Government, and although the cost plus percentage form was considered the least desirable, it was found, for a considerable time, to be the only practicable form which could be adopted under the stress of circumstances. Later, however, modifications and improvements were introduced gradually and, in many instances, a bonus was offered to the contractor on any saving, under an agreed estimated cost.

The successful execution of a "cost plus" contract, whether on percentage or fixed fee, largely depends on the character of the chief contractor and his ability to control the execution of the work. Almost invariably his character will be found to pervade the entire work. It is for this reason that percentage work must be awarded by personal selection rather than by competition, and as personal selection may have the appearance of favoritism, it will be difficult to establish the practice on municipal or other public works.

Mr. Glaeser.

FREDERICK GLAESER,* ASSOC. M. AM. SOC. C. E. (by letter).†—The writer is strongly imbued with the idea that the functions of the engineer do not end with the preparation of a set of specifications and drawings for a particular piece of work, but, like those of the sculptor, must include its completion, as created in his brain, even to the last detail of construction; he must not place on a second party, called a contractor, the responsibility for carrying out the plan. The thought which the writer desires to convey is that the middleman, as in merchandising, is a source of expense that possibly may be done away with in the future. This thought is highly important in these days of high prices, when expenses are pyramiding one on top of another, and, it is believed, the greatest opportunity for the engineer to do constructive service to-day lies in developing his executive powers, in order that he may be able to carry out properly a pre-arranged construction programme.

We all credit the contractor with the "know how", and, being in business to secure his living, he must earn it; but, because of the gamble that he must invariably take, he is bound to protect himself so that he will not lose. The natural thing, therefore, for him to do is, of course, to bid sufficiently safe so as not to pay for the privilege of doing the work. We have all had experience with various classes and

* Trenton, N. J.

† Received by the Secretary, September 12th, 1919.

types of men, and know that some must be watched more closely than others. Mr. Glaeser.

During the last two years, the writer has had opportunities to judge of the "cost plus" contract in its various phases, and is entirely in accord with, and a strong supporter of, the type. The forms used have included the "percentage fee" on a sliding scale; the "fixed fee" form, in which the fee was agreed on by both parties and usually was a certain percentage of the estimated cost agreed on by the owner and contractor before the work was begun; and, latterly, on small jobs, due to the fact that surplus materials were available, and because materials could be purchased at Government prices, the policy has been to assemble all the materials at a convenient storehouse or storage pile and ask for bids on furnishing the labor and equipment required to perform the work. This form of contract is limited in its application, necessarily, but has the advantage of employing the man who possesses the knowledge and experience, but lacks the capital. It has been proven to result in considerable economy. On work valued at approximately $100 000, made up of seventeen jobs, it has been possible, with a gang of general average characteristics, to save a considerable sum.

If it is necessary to enter into a contract, the ideal form, in the writer's opinion, and that which permits of more elasticity in its operation than those at present in vogue, is one in which the estimated cost is agreed on, the fee fixed at a certain sum subject to adjustment in one of two ways, namely, a bonus if the actual cost is less than the estimated cost, and a penalty if the actual cost exceeds the estimated cost. It will be admitted that changes in plans may change considerably the cost of the work, but in that case the ingenuity and knowledge of the engineer is brought into play, adjustments are made on the basis of the original contract, and additions or subtractions are made from the sums involved. The tendency of this form of contract to make the parties thereto feel that a partnership exists, which can be beneficial to both, is an incentive with unlimited possibilities, and results in economy not otherwise obtainable.

In continuation of the idea expressed in one of the foregoing paragraphs, it would seem that one of the functions of a National Engineering Society would be the proper supervision of the execution of Federal, State, and Municipal undertakings of an engineering nature. It would seem that such a society, through its various local associations, could be so in touch with civic improvements as to bring about a considerable reduction in the cost of engineering works. This could be done by providing a clearing house through which the various services necessary for any piece of work could be supplied. Tools and equipment could be purchased or hired, and the middleman eliminated. Such a combination would give the engineer the opportunity to lessen the burden on the tax-payer, to reduce the cost of living very greatly, and to give a maximum of service to the community.

Mr. Snyder.

GEORGE D. SNYDER,* M. AM. SOC. C. E. (by letter).†—There is one method of constructing engineering work that was not referred to in the paper and was only mentioned incidentally in the discussion, that is, where the engineer executes the work without the medium of a contractor, by employing labor and purchasing material, either in his own name or that of the owner, thereby becoming the owner's agent. By this means, instead of having three organizations to deal with—the owner's, the engineer's, and the contractor's—there are only two, the owner's and the engineer's.

When an engineer is retained to design and execute an engineering work, and the owner engages a contractor to do the actual construction, what he is really doing is employing a man who is skilled and experienced in the business of constructing to execute the plans and specifications of the engineer, whose remuneration is fixed in the contract whether it be a lump sum, by unit prices, or some form of "cost plus". In any case, he must produce a cheaper or better structure, or he must produce it in less time than it could be done without him, in order to justify his existence. In other words, he must effect sufficient saving to recompense himself, and, in addition, effect a saving to the owner in money or time. As a matter of fact, on most works of the usual character, under stable conditions of prices of labor and material, the contractor does justify his existence.

No general rule can be laid down as to which type of contract is preferable, as each has advantages under certain conditions.

The lump-sum form of contract is preferable where the character of the work is not unusual and where the quantities can be determined accurately in advance. It has the advantage to the owner of enabling him to figure with some accuracy, even allowing for a certain percentage of extras, on his probable capital outlay.

The unit price contract is preferable where the quantities cannot be determined accurately in advance.

The "cost plus" contract is more adapted to work where there is not sufficient time to work out full plans and specifications in advance, or where complete data as to the conditions to be met cannot be obtained.

The conditions adaptable to the work being done directly by the engineer are as follows, some of which however apply with equal force to the "cost plus" method:

1st.—Works of unprecedented character and difficulty.

2d.—Works where the time element is the ruling consideration and where there is not sufficient time available to work out completely and develop the plans and specifications before starting the work.

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* New York City.

† Received by the Secretary, September 16th, 1919.

Mr. Snyder.

3d.—Works likely to extend over a long term of years during which marked changes in the prices of labor and materials and in the conditions under which the project is financed, may occur.

4th.—Works on which safety is the dominating consideration, where changes and alterations are to be made in a structure without discontinuing its use by the public.

Among works of unprecedented character and difficulty may be mentioned the completion of the Hudson River Tunnels of the Hudson and Manhattan Railroad. At the time work was resumed on these tunnels, the project had a bad financial history. The company had been in the hands of a receiver, and several contractors had been unable to complete the work. Therefore, when the owners invited bids to complete the project, the bids were so high that it was decided to reject them and execute the work at cost under the direction of the engineer. This was so successful that the entire system, with the exception of portions of the work on the land approaches, was done in this way.

The Hudson River Tunnels are also an illustration of the advantage of using this method where the time element is the ruling consideration, for if no work had been done until complete plans and specifications had been worked out, it would have delayed the ultimate completion very much. As it was, when the tunnels were partly completed, the management changed the plans in order to permit the use of multiple-unit trains instead of single-unit trolley cars, which was done without discontinuing any of the work in hand.

In regard to works extending over a long term of years, two instances may be mentioned, one having been done at cost by the engineer and the other by an ordinary unit price contract. The financial panic of 1907 involved both owners so that they could not continue the work on account of their inability to get funds to meet bills and pay-rolls. In the first case, the construction of portions of the work was suspended without any legal or other difficulty, while, in the second case, a settlement had to be made with the contractor to compensate him for his loss due to the suspension of the work.

A case involving safety may be mentioned, namely, the alterations to the Center Street Loop to conform to the plans for the Dual Subway System after two of the tracks were in operation. In this case, a contract was let to the operating company to do the work at cost, and the work was executed under the direction of its engineers. It would have been very difficult to have drawn a contract that would have safeguarded the public and, at the same time, properly recompensed the contractor for the extra work necessary to do this in any other form of contract.

In doing work at cost, under the direction of the engineer, it is essential that he shall have the necessary experience and organization and that the necessary arrangements in regard to plant can be made.

Mr. Snyder.

In cases where the plant is special, or where it will not have a longer life than that necessary to complete the work under consideration, it must be purchased and charged off to the work regardless of the character of the contract. Where the plant is very expensive in proportion to the cost of the work, and cannot be leased, it may be necessary to let the work to a contractor having a suitable plant.

To claim that the same efficiency of labor cannot be obtained on a cost job as on a contract job is an admission of inefficiency on the part of those directing the work. Of course, it is human nature for a contractor who has both contract and force account jobs under way, to assign his best men to the contract job; but there is no such incentive where the work is being done by the engineer directly as agent for the owner.

Doing work by the engineer without the medium of a contractor is applicable to public work, where State laws do not preclude such a method, but trouble may be had with labor owing to civil service requirements and rulings. Some of the Federal river and harbor work is executed by direct labor.

The advantages and disadvantages of these methods vary with the character of the work, the local and financial conditions, and the owner's desires, and the engineer should not limit himself to any one method of executing his plans, but should freely use those best meeting the conditions.

Mr. Baum.

F. G. Baum,* M. Am. Soc. C. E. (by letter).†—The writer thinks that the "cost plus", or percentage, plan of doing construction work is an abomination and a practice which leads almost inevitably to loss of control of the cost of the work and loss of confidence of the owner in the engineer and contractor.

The contractor or engineer may be ever so honest, but the moment the men in his employ know the job is a percentage job, they think they are being loyal to their employer if they make all the "percentage" they can. This applies from the top down to the last laborer. The writer has heard the men (big and little) brag about how they "put it over" for the boss. Until human nature changes, the "cost plus" plan must lead to great dishonesty. The author admits:

"There can be, of course, great dishonesty under 'cost plus' contracts, but, if this occurs, it is the owner's fault in lax supervision of his own forces or from incompetent or dishonest engineers."

That is a remarkable statement. What control has the owner over the contractor's dishonesty or that of his men, or their competency?

The writer has always made it a practice to have nothing to do with the "cost plus" plan, except where no other course could be followed;

* San Francisco, Cal.

† Received by the Secretary, September 22d, 1919.

and he thinks engineers, contractors, and architects, generally, will obtain a higher standing, if they abandon it entirely, except in emergency cases. Mr. Baum.

GEORGE PERRINE,* M. AM. SOC. C. E. (by letter).—†"A contract is an agreement between two or more parties for the doing or the not doing of some definite thing."‡ Mr. Perrine.

In construction contracts the contractor agrees to do certain work and furnish the necessary materials for stated prices, for which he is to be paid by the owner. The prices are always stated in the contract, and the units for which these prices are to be paid can be accurately measured or counted.

For doing certain work described in the specifications, including the furnishing of all materials enumerated in the contract, the contractor expects just compensation (in addition to actual costs) for his services and experience, and the use of his organization, plant, and money in prosecuting the work.

The owner knows what the completed work will be worth to him; if it is a factory, it will give certain returns in rent, and so with other things, a value can be set on them. In order to fix the value, the owner engages an engineer or architect to make the estimates. If he is a good business man, he will engage an experienced adviser, as an insurance against serious mistakes in fixing the the value of his new property.

The owner has the estimate of his expert from which to judge the amount of capital involved; then he advertises for bids. Usually, such bids are called for as unit price or lump sum; in either case, the bid prices are to include the cost of the contractor's services and his profit. A number of contractors will bid, their bids varying more or less from the figures of the owner's expert. The expert can judge very closely from experience by comparison with the contractor's bids how much the contractor will probably realize for his services.

The contractor's first thought, when making up his bid, is: How much money has the owner appropriated to do the work? The next is: Who are to be my competitors? Then he bets a certain amount on his skill against that of the other contractors.

If the contractor's figures are much lower than those of the owner, the supposition is that he will lose money if awarded the contract and, therefore, trouble and disputes will arise between the contractor and the owner, which may be more expensive in the end than if a contract had been let to a reliable contractor at the owner's figures.

There are certain things for which the actual costs can be fixed before commencing construction. Quotations can be secured, good

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* New York City.

† Received by the Secretary, October 9th, 1919.

‡ "Contracts", by Parsons, Vol. I, p. 6.

Mr. Perrine.

for a stated time, for materials and plant rental, these cost prices to hold good while a contractor is being selected.

After these provisional agreements are made, and a contractor is found who will be willing to do the work at the owner's estimated cost, the owner can decide whether or not he wants to build at the prevailing market prices. He then has his expert estimate the probable cost and fluctuation of the prices of labor, and the cost of labor and materials are added together to obtain the probable net cost of the work.

The owner knows what he can afford to pay for what he expects to get under the terms of the contract, but is often uncertain as to the personal ability and integrity of some of the contractors and their forces. If a contractor is losing money, the owner will probably have some difficulty and be put to additional expense to guard against getting poor material and workmanship.

It should be possible to guard against such conditions by letting a contract to one of several selected firms, the contract to cover the cost of the work based on the owner's estimate for the actual cost, including overhead expenses and the contractor's fee. The contractors who are invited to bid for the work should be required to divide their bids into three parts, net cost, overhead, and fee desired.

In order to give the contractor an incentive to save money, he should share with the owner any saving below the latter's estimated cost.

It is the duty of the owner's engineer to see that the contractor does not turn out poor work, in order to make a saving and, thereby, get an extra profit. It is also his duty to see that his inspectors' methods do not retard the contractor's forces.

The owner's engineer should add to his net cost the contractor's overhead charges and fee and a certain amount for contingencies. When the contractor signs the contract, he accepts the approved estimate of cost and contingencies as final and binding.

The contractors under consideration by the owner should be requested to examine the plans and make their own estimates, in order to decide whether they are willing to accept the contract based on the engineer's estimate.

If, in figuring the contractor's fee, the total cost of the contract should exceed the net cost plus, say, for example, 50% of the estimated contingencies, a deduction should be made in the contractor's percentage fee, by an amount in proportion to that which the cost exceeds the net cost, plus 50% of the contingencies. The object of this is to compel the contractor to exercise the best supervision in order to keep down the costs. By such a contract, the owner pays no more than his engineer estimates the cost to be, and the contractor has the opportunity of increasing his profit by exercising his skill. Orders for extras may be figured on the same basis as those for the general contract.

P. L. Reed.* M. Am. Soc. C. E. (by letter).†—When a prospective owner has decided to apply his funds to the construction of some structure or other engineering work, he may handle it in one or several ways: Mr. Reed

(*a*) Employ the necessary foremen, mechanics, and laborers; purchase the necessary materials; and supervise the construction.

(*b*) Employ one or more superintendents on a salary basis and delegate to them the authority to hire some or all foremen, mechanics, and laborers; and to purchase some or all of the materials; and entrust to these superintendents the application of the labor and the materials.

(*c*) Employ a contractor on a "cost plus" basis and delegate to him most or all of the authority to employ labor, purchase materials, and apply them to the work to be accomplished.

(*d*) Enter into a fixed price or fixed unit price contract by which he delegates all authority for employment of labor, purchase of materials, and their respective applications.

Method (*a*) is "day labor" or "force account"; Method (*c*) is "cost plus"; Method (*b*) is an intermediate stage between Methods (*a*) and (*c*); and Method (*d*) is "contract" work.

It is to be noted that Methods (*a*), (*b*), (*c*), and (*d*) involve increasing delegation of authority, but that in Methods (*a*), (*b*), and (*c*), the owner retains the financial responsibility for results, and that only in Method (*d*) is he relieved of this. As Methods (*a*), (*b*), and (*c*) involve increasing delegation of power to spend without definite responsibility for costs, they imply increasing degrees of confidence or trust by the owner in his agents, coupled with financial supervision in different proportions according to circumstances. This element of trust which attains maximum proportions in the "cost plus" method of doing work is of so intangible a nature as to put this method under a great handicap in the award of public works, in normal times, and where competition is keen, even when permitted by law.

The author has suggested that "cost plus" contracts could be let on the basis of fee demanded, on the contractor's resources, and on his reputation. The only really tangible item in such a valuation of a competitive proposal would be the amount of the fee demanded, and to attach much weight to this item would be like selecting a doctor, a lawyer, or an engineer on a similar basis. The vital question is how well will he perform. The really important items are the intangible ones, and it must always be difficult, if not impossible, in

* Washington, D. C.

† Received by the Secretary, October 16th, 1919.

Mr. Reed.

normal times, to justify to the satisfaction of public bodies, awards of public works on such considerations.

The author explains the difficulty arising under fixed price contracts from extras, actual or alleged, which are largely avoided under "cost plus" contracts. On the other hand, the "cost plus" contract brings its own difficulties in the general control and auditing of the contractor's expenditures and in deciding what items are properly to be included in the cost of the work and what items are chargeable to the contractor's account, particularly as to items of indirect or overhead expense. Both kinds of difficulties, of course, are minimized by definite and complete plans and specifications in the case of the fixed price contract and a definite and comprehensive contract in the case of the "cost plus" contract.

In his advocacy of the "cost plus" method, the author suggests that the gamble belongs to the owner and mentions the uncertainties of site, weather, and varying market conditions; but what should be said about the gamble of competent and honest supervision and direction of purchases, plant, construction schedules, and organization and application of working forces? This latter part of the risk, and it is an exceedingly important part, belongs as logically to the contractor. If it be urged that the owner, himself, may supervise these things, then the contractor becomes little more than a salaried superintendent and we approach "day work" or "force account".

However, the gamble may be conceived to be divided in origin. It is within the power, and it is the practice, of the two contracting parties to distribute it as they may agree. In some cases, the owner may be in a better position to assume the risks of the enterprise, in some cases the contractor; but, independent of this, one party may be more willing to assume risks than the other, and this will have a material effect on the form of the contract drawn to accomplish the "meeting of the minds".

The facilities of modern trade enable one to take risks or transfer them to others within a large range. A miller may buy his grain on the Exchange before it is harvested, for a definite price per bushel for future delivery, and we are told that various crops, such as fruit, are not infrequently sold by the producer for a definite lump sum on the trees, before they are ripe. We may carry insurance of many kinds to relieve ourselves to a large extent of various risks. An owner, either an individual, a private corporation, or a city, may have a sound reason for placing a contract for some improvement at a definite lump sum price, with the contractor assuming all risks. Nor does it follow that a fixed price contractor in assuming risks charges, in the long run, for contingencies which do not happen and that, on the whole, the owner pays more than he would had he assumed the risks. The contractor would naturally prefer to cover in his fixed

price all possible contingencies, but if he did he would get little or no work in competition, and it is doubtful if, as a whole, contractors, in their estimates, do cover the contingencies which actually develop. Mr. Reed

In manufacturing, the man in the shop may be paid by the hour or by the piece, with or without bonuses, premiums, or other elaborations. Both basic methods have been in use for many years, and there is yet no consensus of opinion as to which is the better. It is probable that each is to be preferred under certain conditions. Similarly, in contracting, the contractor, like the day worker, may be compensated by a fee, regardless of efficiency of performance, under a "cost plus" contract; or, like the piece worker, he may be paid a fixed price for accomplishing a definite result. In this case, too, the method to be preferred probably depends on the circumstances.

Recognizing that in the maximum delegation of authority to spend without definite responsibility for costs and incentive to economy lies the inherent defect in the "cost plus" contract, various modifications have been made in these contract forms.

The general types may be indicated as follows: (*a*) cost plus a percentage fee; (*b*) cost plus a percentage fee with a fixed maximum cost; (*c*) cost plus a percentage fee with a maximum fee; (*d*) cost plus a fixed fee, based on the estimated cost of the work; (*e*) cost plus a fixed fee with a bonus represented by a definite proportion of any savings effected in actual cost below the estimated cost. A limit may be set to the amount of the bonus; (*f*) cost plus a fixed fee with the bonus for saving as in (*e*) and a penalty represented by a definite proportion of any expenditure in excess of the estimated cost. A limit may be set to the amount of the penalty so as to leave a minimum fee.

It will be evident on consideration that Modifications (*b*), (*e*), and (*f*) of the simple "cost plus" forms are essentially compromises between the straight "cost plus" and the fixed price forms, and that they serve to divide the risks which the owner carries in a straight "cost plus" contract and which the contractor carries in a fixed price contract.

The exceptional conditions produced by the war had as elements: (*a*) The importance of a prompt commencement and vigorous prosecution of large and complicated projects of indefinite extent and detail, with economy a distinctly secondary consideration; (*b*) large, rapid, and uncertain fluctuations in prices of material and wages of labor; (*c*) serious disturbances in the normal operation of the law of supply and demand; (*d*) an exceptional degree of patriotic feeling which minimized fraud and induced impersonal devotion to the work.

These conditions were favorable to the "cost plus" method in the execution of public works. When a contractor is given a "cost plus" contract, he is essentially appointed to a position of trust, and the

Mr. Reed. general power of committing the Government or a city to this relation is not one which the public will lightly place in the hands of its contracting officers in normal times.

Mr. Wheeler. WALTER H. WHEELER,* ASSOC. M. AM. SOC. C. E. (by letter).†—The author sets forth in his paper certain advantages claimed for the "cost plus" contract over the "lump sum" or "item" form of contract, and invites discussion of the question.

There is little doubt that the majority of contractors favor "cost plus" contracts. On the other hand, it is the writer's belief that very few owners favor this form of contract, and there are certain good reasons why they should not, except on certain classes of work, such as repair work and excavation and grading where the kinds and quantities of materials are difficult to determine. The writer has been fortunate in his experience in being at various times a principal on construction in the capacity of engineer, contractor, and owner, and thus has had opportunity to observe and study contracts from these different viewpoints.

It seems clear that most of the advantages claimed for the "cost plus" contract vanish completely for most construction work, when the engineer who draws up the plans and specifications, performs his duty thoroughly, conscientiously, and intelligently.

One of the stock arguments which is often advanced by contractors in favor of the "cost plus" contract, is the time to be saved by letting the contract and starting the work before the plans and specifications are complete. This is a very specious argument, and frequently owners are persuaded to let their contracts in this manner, cherishing the belief that time will be saved. Rarely is this expectation realized. On the contrary, the result is usually disappointing to the owner. Time usually is actually lost in straightening out the errors and mistakes that have been made in starting before everything had been worked out carefully on paper, and the cost, instead of being reduced, is increased, on account of the inability to organize the job properly for efficiency, because of lack of knowledge of all the details of the work involved and through the errors previously mentioned. One reason why this argument of saving time is used so often by contractors who are after a certain piece of work, is obviously because they well know that after all the plans and specifications have been worked out, they will not have convincing arguments to present in favor of the "cost plus" contract. Certainly, no greater mistake can be made than to begin any undertaking, whether construction or other enterprise, without proper preparation, and proper preparation in a construction enterprise certainly involves complete plans and specifications.

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* Minneapolis, Minn.

† Received by the Secretary, October 17th, 1919.

Mr. Wheeler.

In the absence of complete plans and specifications, the basis for a clean-cut contract is lacking. Under certain circumstances, haste in beginning work is sometimes justified, such as the necessity of retaining right-of-way rights, title, or some similar reason. However, it is not necessary as a rule to let a contract for more than a small part of the work in order to accomplish such a purpose, and the plans and specifications for the major work can be worked out while the contracted portion is in progress.

It is the duty of the engineer to advise and even insist that his client have enough exploration work done to furnish reliable data on which to base his plans. Such work is usually relatively inexpensive and will frequently result in an entirely different plan being used. Often, in this way, many times the cost of the exploration work is saved. Engineering is or should be an exact science, and unless one has exact data on which to base plans and specifications, one is working on guesswork and not on fact.

It is argued that "cost plus" contracts save money for the owner. It is possible that such results are sometimes attained, or could be if plans and specifications were worked out with the same care and completeness under this system as they would be under the "lump sum" system. Here, in the writer's opinion, lies one of the dangers of the "cost plus" contract to the Engineering Profession. Regardless of how conscientious the engineer may be, he is almost certain to be less thorough in his work when he knows that there will be no "come-back" at him on account of extras resulting from his failure to have his plans and specifications complete, because it will simply be a matter of correcting the error or supplying the deficiency when discovered; but the cost is there just the same, although it may not appear as an "extra". The writer is very much inclined to be skeptical as to the saving that can be made on the cost.

Another argument advanced for the "cost plus" contract is the ease with which changes can be made as the work progresses, and one might get the impression from reading the paper that since these changes are easily or more easily made under the "cost plus" contract, they involve no additional cost because of the change. On the contrary, every contractor knows what it means to be making frequent changes in plans after work is started, or, worse yet, to be correcting or changing work which is already in place, and the greatly increased cost that results over what such cost would have been had the work been done that way in the beginning. Here, again, is another pitfall for owner and engineer. When the changes have to be taken up and their cost arrived at before they are made, as under the lump sum contract, the owner is impressed with such cost. Under the "cost plus" contract, the owner often does not awaken to a realization of the cost until the job is done and the final cost is known, and, in

Mr. Wheeler.

many instances, the job has not been finished, because adequate funds were not provided in the beginning to cover the total cost; or, if it is finished, it is a disappointment from an investment standpoint, as all the preliminary calculations are upset. Here, again, a heavy responsibility rests on the engineer to see that his client, and also that he, himself, studies the work so thoroughly and considers every detail so carefully while the plans are in preparation, that it will not be necessary to make changes after the contracts have been signed.

The writer cannot agree with Mr. Clarke's assertion that the "lump sum" contract has not the advantage of showing the cost of the work before starting, and that there is "invariably a long list of extras." If there is this "long list of extras", the writer would be inclined to place at least a part of the blame on the engineer who prepared the plans and specifications. He knows of considerable important work that has been carried through without, or practically without, a single extra. However, he sees no good reason why extras under the "lump sum" form of contract should be so difficult, provided a schedule of prices for extra work or deductions to cover contingencies is required of the contractor when the contracts are signed.

It is vitally important to the owner that he know very closely what the work will cost him before he awards the construction contract. There are many instances where owners have relied on the estimates of engineers or architects for the cost of the work or on the estimates made by contractors based on preliminary plans or sketches, with disastrous results. There are even instances where unsuspecting owners have been encouraged to go ahead with work, usually on the "cost plus" system, by willfully misleading estimates, and, in some instances, have met with financial ruin as a result. In the writer's opinion, the engineer, architect, or contractor who so misleads an owner, either knowingly or through ignorance, should be severely punished under the law, and certainly this Society should not countenance anything of the kind and would not if the writer correctly understands its ideals.

The same principles will hold good on the argument that better workmanship is secured under the "cost plus" contract. It is simply a matter of making the plans and specifications clear and definite and seeing that they are followed, which would be just as necessary under the "cost plus" system. The writer can see no reason why the contractor bidding on a lump sum contract should have to "guess at" the meaning of the specifications. He has the privilege of making definite, by correspondence with the engineer, anything that is indefinite or difficult to interpret. If the plans and specifications are well drawn, why should there be anything in them that is indefinite? Is it not for the engineer to see that his plans and specifications are intelligible?

Mr. Wheeler.

It would seem that for most work the "lump sum" form of contract comes nearest to meeting all the conditions and requirements of construction work in the best manner, and it is a matter of the engineer's ability, intelligence, and integrity to make it work out smoothly, fairly, and properly.

It is only fair to the contractor that he be protected against increases in wages, freight rates, and other contingencies such as strikes. As to material prices, he can secure protection for a long enough time to enable him to place his orders, and if he is negligent that is his lookout.

It seems to the writer that for public work the "lump sum" is much to be preferred to the "cost plus", as there are already too many opportunities for polities and "wire pulling" and these, in the writer's belief, would be increased by the adoption of the "cost plus" contract.

Mr. Walker.

E. G. WALKER,* M. AM. SOC. C. E. (by letter).†—An examination of this paper leaves the impression that its author is a strong advocate of the "cost plus" form of contract, almost to the exclusion of other forms. In his strong advocacy of it, he enumerates a number of points which he reads as great advantages of the system, but which to many other people would appeal rather as disadvantages. The whole question as to the best form of contract to be used for a particular job turns entirely on the circumstances under which the contract is being issued, and it is practically impossible to say that one form is better than another unless the particular circumstances of each case are taken fully into consideration.

In general, in engineering practice, there are three parties primarily involved: (1) the owner; (2) the engineer; and (3) the contractor. The second and third parties have their status fairly closely defined, in that they are individuals or firms who specialize in their particular branches and are bound by the laws and customs of their respective professions. The owner, on the other hand, is drawn from the widest possible limits and may be a unit of any size, from a single individual to the whole nation. Further, he may be technical or non-technical, and the work which he is having done may or may not be embarked on for profit.

A still more important feature is that the nature of the work to be undertaken is in some circumstances definitely known before the contract is entered into. In other cases, it may be possible at best only to obtain an approximate idea beforehand of what has to be undertaken after the job has been started. To meet all these varying conditions and circumstances requires the development of several different types of contract. At the present time, conditions are probably much more favorable to the "cost plus" system than they are likely to be in more

* London, England.

† Received by the Secretary, October 29th, 1919.

Mr. Walker.

normal times, because, owing to shortage of materials and fluctuations of wages, it is difficult in many cases to get contractors to commit themselves definitely to prices for the necessary time ahead, which they have to do if they tender on the ordinary lump-sum basis.

The impression left by the author's case for the "cost plus" system is that when this system is developed to its utmost, the owner virtually becomes his own contractor, except that he hires the plant from the regular contractor and utilizes him as a kind of extended ganger over the working force. All responsibility as to the actual carrying out of the work is apparently to be left to the owner, who is also to shoulder all trouble that occurs with labor, and all risks, and to insure remuneration to the contractor no matter how the work may turn out. This seems to be rather an inversion of the ordinary notion. The writer believes that the generally accepted idea is that a contractor is paid and allowed to take profit on work mainly by reason of the fact that he is prepared to relieve the owner from the responsibilities of carrying out the work, and in the majority of cases it is believed that the principal advantage that owners see in putting work out to contract, is that their expenditure will be known beforehand within reasonable limits, and that the responsibility for the proper carrying out of the work will be largely taken off their shoulders and put on those of reputable specialists who are more competent to carry it than they are.

A point which the writer does not understand is that the author, in his concluding paragraphs, appears to imply that the "cost plus" system is eminently desirable for municipal work, although immediately before this he admits that this system allows of great dishonesty. The two statements appear to the writer to be incompatible, since it is self-evident that anything which allows of the development of greater dishonesty than the old system of contracts is hardly suitable for application to public bodies, in which, by the nature of their formation, the responsibility of the individual member is limited.

The writer believes that in general the standpoint to be adopted in deciding what type of contract shall be used in any particular case should be broadly that the job should be classified as either one of two types: (*a*) straightforward jobs, that is, jobs in which the amount of work to be done can be fairly closely estimated beforehand; and (*b*) uncertain jobs, that is, those in which this cannot be done. When the supply of material and labor is normal, jobs of the first class can be priced with a reasonable degree of accuracy, and for such work, in the majority of cases, it will probably be found that the owner prefers the old system of competitive tender, because his liability is fixed within moderately close limits thereby. In this class of job, alterations and additions to the original design are only small, and their value, therefore, will be only a small percentage of the original tender.

With a priced schedule, the contractor does not stand a particularly abnormal chance of making a harvest on his extras, and even should his profit on them be at a greater rate than on the main contract, the actual money value is unlikely to be great enough to allow him to make an abnormal profit on the whole contract, and it is on the whole contract rather than on a few items in it that a true comparison should be based. Mr. Walker.

The second class of job is obviously the more difficult to deal with, and the two types of contract which can best be considered in connection with it, are the itemized schedule type and the "cost plus." It is probable that, in most instances, the "cost plus" will give the better results. In certain cases, it is evident that the owner must be prepared to face considerably more risk, and that his engineer must also be prepared to take more responsibility for the issue of technical instructions and orders in connection with the job. Furthermore, as the magnitude of the risk is uncertain before the job is started, it is obvious that a contractor is not in a position to estimate fairly what the work is worth to him and, therefore, must cover himself by a higher price. With the correlating circumstances that the owner is to take more risk, and the engineer more responsibility for technical supervision, a number of the disadvantages of the "cost plus" system referred to by the author are considerably reduced in importance. The writer believes that it is to this type of job that the "cost plus" system is more applicable, and he does not believe that it is a desirable system to use indiscriminately for all types of contract, and, in particular, he is of the opinion that considerable caution should be exercised in its application to cases in which public bodies are the owners.

J. A. L. Waddell,* M. Am. Soc. C. E. (by letter).†—The importance of the subject of this paper, to owners, contractors, and the entire American nation, cannot well be exaggerated; for, until there is reached a satisfactory compromise between owners on the one hand and contractors on the other concerning the vital questions of contract-letting and profit-sharing, the business of the country will fail to recuperate to the extent that it should at this critical period in the readjustment of all constructional activities—which activities were so fundamentally upset throughout the whole world more than five years ago by the advent of the World War. The opportunity now within easy reach of the American people to secure the bulk of the world's trade is unique; but, apparently, our leaders in diplomacy, manufacture, shipping, business, and finance are either unaware of its existence or indifferent about taking advantage of their good fortune. The Latin-American nations are now knocking at our door Mr. Waddell.

* New York City.

† Received by the Secretary, October 24th, 1919.

Mr. Waddell.

asking to do business with us and begging us to lend them money for the development of their as-yet-almost-virgin lands, mines, and water powers, and their other more or less embryonic resources; and the leading peoples of Asia, Africa, Australasia, and even Europe are to-day much more willing to enter into business relations with this country than they have ever been before. They all recognize that, for the present at least, the European countries are in no condition to lend money, being themselves borrowers and having so many demands at home for their time, attention, and capital that they are unable to pay attention to the needs of any nation but their own; and the entire civilized world is well aware of the fact that, in spite of our vast war debt, we are to-day the most wealthy of all peoples.

These conditions—unfortunately, as far as we are concerned—will not last indefinitely; and if we are so short-sighted as to neglect to seize the golden opportunity which is not only easily within our reach, but which is actually being tendered to us and almost forced on our acceptance, it will not be long before both England and Germany will re-secure the grip on the world's trade which they possessed in ante-bellum days.

Prevention of Progress.—One of the greatest stumbling blocks in the pathway of our nation's advancement is the conflict between labor and capital; and until it is removed the wheels of progress will be clogged, and the present paralyzation of all great peace industries will continue to exist—possibly in even worse form than it does to-day. Again, the main issues between labor and capital are these questions of contract-letting and profit-sharing. If they were once settled to the satisfaction of all concerned—bankers, manufacturers, contractors, and workmen—all other minor differences would quickly be adjusted. Such a settlement is perfectly feasible; and the possibility of its speedy accomplishment is neither a Utopian conception nor an idle dream.

Primarily, the men who do the work must have a substantial share in all net profits of manufacture and construction; but the way for them to obtain it is not by the organization of strikes nor by seizing the plant and running the business of the manufacturer or the contractor. The uneducated workman is no more fit to manage business and to handle industry than the sedentary office man is to undertake the physical labor of the workman—in fact, much less so; because it would generally be totally impracticable to educate the illiterate workman up to a state of efficiency which would enable him to undertake business management and finance, while, in most cases, in a comparatively short time, the office man's muscles could be developed sufficiently to enable him to endure the physical stress of the workman's job. Nothing of value can be accomplished by mob rule, as the pending subsidence of the present wave of Bolshevism will soon prove.

Mr. Waddell.

Labor and Capital.—Although it is certainly true that the laborer cannot succeed independently of the business man, it is equally true that the latter cannot accomplish much without the aid of the capitalist, hence it behooves business men and financiers to come quickly to a friendly understanding and agreement. In times past, the capitalist secured and exercised a strangle hold on the promoter, the manufacturer, and the contractor, often forcing them to turn over the lion's share of their profits as compensation for the use of money in the development of their undertakings; and these men in their turn endeavored to even up matters by getting their pound of flesh out of the workman by compelling him to labor long hours for meager compensation. To-day, the laboring man is beginning to come into his own; but if he unwisely takes too great advantage of his growing power, he will "kill the goose that lays the golden eggs", and this will ruin his chance of securing comfort and happiness for himself and his family.

The first step requisite for quieting the existing widely spread popular unrest and returning to normally prosperous conditions is to bring together, so that they may operate in harmony, the financier, the employer, and the laborer; and this must be accomplished primarily by establishing some method of contract-letting and profit-sharing which will be just and equitable to all parties interested. For some time, the writer has been endeavoring to formulate and develop, through communications to the technical press, an ideal method of accomplishing this desideratum; and later herein he will indicate clearly of what it consists. Meanwhile, he will discuss in detail not only the suggestions offered by Mr. Clarke in his timely paper, but also those of various engineers and political economists who have of late been treating the matter in print.

Various Methods of Contract-Letting.—The most common ways of contract-letting are the following:

A.—Lump sum for complete construction.

B.—Schedule rates for all materials in place.

C.—Actual cost plus a percentage, with some kind of allowance for overhead expenses.

D.—Actual cost of labor and materials plus a percentage, with no allowance for overhead expenses.

E.—Actual cost plus a lump sum, with some kind of allowance for overhead expenses.

F.—Actual cost of labor and materials plus a lump sum, with no allowance for overhead expenses.

G.—Actual cost plus a profit based on small unit prices agreed upon in the contract, as advocated of late by Mr. G. H. Hailey.

H.—Various methods of profit sharing between the client and the contractor.

Mr. Waddell.

Method *A* generally appeals best of all to the client, because it fixes in advance what the construction is going to cost him, unless, perchance, there are important variations in the estimated total quantities of materials, due to lack of sufficient preliminary information or to the encountering of conditions that could not well have been foreseen. It is by no means as satisfactory to the contractor, however, who has to run the risk of being actually out of pocket on the job, in addition to the loss of personal time and effort.

Method *B* is quite an improvement on Method *A*, in that the contractor does not have to guarantee the correctness of the estimated quantities of materials; but the prime objection to Method *A* holds good for Method *B*, as the latter does not prevent the contractor from losing money heavily on the venture.

In the days of hard times, when contractors are willing to take work at low figures, and even below cost, in order to keep their force together, the public, in general, especially as represented by companies and municipalities, is prone to take advantage of them by insisting that work be let by the lump sum, and by throwing on the unfortunate "successful bidder" not only the risk of loss from rising prices of materials and labor and from unforeseen contingencies, but, also, in many cases, from excess of quantities above those given in the specifications. This is accomplished by inserting in the latter a most unjust clause compelling each bidder to verify for himself both the quantities stated and the character of the conditions described. The bidders, hungry for work, accept this clause without comment, but with the mental reservation that, in case of hard luck, they will, by some means or other, obtain extra compensation, even if they have to carry the controversy into the Courts.

In nineteen cases out of twenty, it is unjust to bidders to ask them to name a lump-sum compensation for doing work, unless provision is made for a variation in the quantities of materials on which they tender. If provision is arranged for such variation, the method of letting is no longer that of the "lump sum", but reduces to a modification of that of "unit prices".

As before indicated, the latter method is certainly the more logical, and yet it is far from being entirely fair to the contractor; because, although it provides against loss through excess above the estimated quantities of materials, it leaves him open to the possibility of still greater loss through changing prices, onerous unanticipated conditions, and disastrous happenings beyond his control. Up to a certain point, the client is the proper party to assume the principal risks inherent to the work, provided that the adverse happenings are really unavoidable by the contractor, and that the latter takes every reasonable precaution against disaster or loss. And yet the contractor should

Mr. Waddell.

not be altogether relieved from the possibility of loss due to hard luck, because such misfortune is often caused by his dilatoriness, which carries the work into an unfavorable season for field operations. The idea, promulgated of late by certain writers, that it is unjust ever to penalize a contractor, is wrong; because he, like everybody else in this world, should bear the burden resulting from his own carelessness, negligence, or incompetence. The owner surely has some rights—and this is one of them. A liberal limit of total cost which can be increased or reduced properly, in order to provide for an increase or decrease in the estimated total quantities of materials, will prevent the owner from being excessively overcharged, and still will give the contractor every opportunity to come out whole in any case except that of extraordinary hard luck.

Method *C* is wholly objectionable to the client, in that it places him entirely at the mercy of the contractor and his men. The allowance for overhead may be either an assumed percentage, or the actually computed amount in complete detail, the former being generally the less objectionable. Even if the contractor is perfectly honest and has the best will in the world to keep down the cost for the benefit of the client, his employees will not have that desire. In effect, they say to themselves and to each other, "What is the use in my exerting myself unduly? The more the work costs, the more money the 'old man' makes". The writer knows this to be the case, for some years ago he had to let a large contract for foreign work at cost plus a percentage; and although the contractors themselves tried to do the honest thing at all times, their men "loafed" to such an extent that the final cost of the construction was atrociously high; and he had occasionally, on his own responsibility, to discharge some of the contractor's employees, including once the field superintendent. This method of letting work involves asking too much of frail human nature.

Method *D* involves less labor in cost-keeping than Method *C*; but, otherwise, it is open to the same general objection.

Method *E* is almost as unsatisfactory to the client as Methods *C* and *D*, except that the contractor's reward for his own iniquity is a fixed quantity and not in direct proportion to the extent of that iniquity.

Method *F* involves a slight improvement on Method *E*, but only to the extent of a little simplification in bookkeeping and perhaps a reduced opportunity for "squeezing" the client.

The writer readily acknowledges that during war times, when the trend of the market for both materials and labor was rapidly upward, no contractor could have afforded to take work either for a lump sum or by unit prices. Unfortunately, in order to bring the war to a successful conclusion, a vast amount of public work had to be done

Mr. Waddell.

with the utmost despatch, irrespective of what the cost might be; hence, the Government had no choice at all in the matter, and, consequently, it let many millions of dollars' worth of contracts at "cost plus a percentage" or "cost plus a lump sum". If the true history of all such contracts was ever written and made public, the nation would stand aghast at the extravagance they involved; and those two methods of contract-letting would receive the universal condemnation of all intelligent, disinterested persons.

As was stated in the oral discussion, when a contractor has simultaneously two or more contracts, one of which is on the "cost plus" basis and the other or others on either the "lump-sum" or the "unit-price" basis, he will naturally put his best and most energetic men on the latter, and will shift the lazy and incompetent ones to the former. This practice has become so well established by custom that the "cost plus" contracts have been dubbed "hospital jobs"; and it appears that the nickname has stuck.

Is it not obvious that any one who lets a contract on the "cost plus" basis places himself absolutely at the mercy of the contractor and the contractor's employees? It is true that the specifications often contain restrictions which tend to lessen the contractor's power to take advantage of the client; but their enforcement would be very troublesome, and would generally involve litigation with its attendant delay and expense.

Most people will acknowledge that the percentage of truly conscientious contractors is not overwhelmingly large, but how much smaller is that of truly conscientious workmen! The writer does not deny that there are workmen who always give a *quid pro quo* and who are upright and honorable in all their dealings; but, alas, they are sadly in the minority. Their number is so small that they are unable to induce their co-laborers to exert themselves any more than they are compelled to, unless they are paid by the job instead of by the day or hour.

By the way, when it is practicable, such a scheme of paying the workmen is an improvement on that of time compensation, because it provides a great incentive to effort; but, at the same time, it also serves as a strong temptation to scamp the work. With close supervision, however, and a strict enforcement of the clause in the specifications relating to the taking out and replacing of defectively built work, the employees soon learn, through the fines and penalties enforced by the contractor, that scamping does not pay, and that the old adage of honesty being the best policy is just as applicable now as it was when first enunciated.

Method *G* involves only a very slight modification of that of "cost plus a lump sum", the said lump sum being replaced by another sum

Mr. Waddell.

obtained by adding together the products of the actual quantities of all the materials by certain small unit prices agreed on in the contract. Although the writer concedes that this method is undoubtedly the best of all the straight "cost-plus" methods, it possesses all the serious objections inherent thereto.

In addition to those previously indicated, there might be mentioned the fact that any straight "cost-plus" basis effectively cuts out competition, and advantages a favored few of the larger and more experienced contractors, rendering it difficult for the smaller and less experienced ones to secure any work, except through some other method of letting. It ought to be evident to any one possessed of ordinary vision that such a method will militate toward cutting the "small fry" contractors out of bidding; for when an owner is willing to let a piece of work on any straight "cost-plus" basis, he naturally will want to award it to a large contractor of means, who has an established reputation for fairness and efficiency. That would practically mean letting all contract work without competition, and American contractors, as a body, would object seriously to any such procedure. It is true that the owner might call for competitive bids on the basis of having each bidder name a lump-sum as a fixed net fee, and awarding the contract to the competitor who quotes the lowest figure; but the adoption of such a method would often result in serious trouble, delay, and expense.

Under the heading *H*, a number of profit-sharing methods have been tried and have proved to be more or less satisfactory. All of them necessarily presuppose a careful accounting of cost from start to finish. Unless the contract between the two parties clearly indicates how every main detail of cost is to be computed, there will be trouble before the work is finished. For instance, in respect to plant —does the contractor furnish it free of charge, or does he receive rental for it, with the rental charged as one of the items of cost of the work? How about paying for repairs and renewals to plant? Who stands the expense of these items—does the contractor, or is it charged as an item of cost of doing the work? Again, if extra work is done under the contract, how is it to be counted when making the final settlement?

It requires the service of an expert consulting engineer or that of an experienced contractor to draft a contract and specifications which will provide, in a manner satisfactory to both parties, for all possible contingencies. With such papers, however, and with a close system of cost-accounting, this general method of profit-sharing is the most satisfactory scheme for contract-letting, which can be evolved.

None of the modified methods of the "cost-plus" system, involving some means or other of profit-sharing, which have yet been tried in practice, can be said to be entirely satisfactory to the owner, though possibly so to the contractor, in that they all fail to put a limit on

Mr. Waddell.

the total cost of the construction or to penalize a contractor who, through either wilfulness or carelessness, allows the cost of construction to pass the bounds of reason. It does not suffice to stipulate in the contract that, when the total cost passes a certain amount, the allowance for profit is gradually to be reduced until a certain minimum limit, however small it may be, is reached. The setting of that limit leaves the contractor in a position to take life easily and to avoid personal worry after his hard luck has attained to a certain magnitude; for, subsequently to that, he will lose nothing but his time and the possible use of his plant on some remunerative contract, while the owner will have to pay whatever additional amount the job may cost. On this point the writer knows whereof he speaks; because one of the war-time contracts engineered by his firm was, of necessity, let on that basis, and the results thereof are simply sickening. The client was left at the mercy of the contractor, and the total cost proved to be excessive.

From the preceding it is evident that the "cost-plus", the "lump-sum", and the "unit-price" methods of letting contracts are not only faulty, but also unjust to one or other of the two parties to the agreement; consequently, the question arises: "Is there not some method which will be just and fair to both? That question, the writer claims, can truly be answered in the affirmative; but before proceeding to explain such a method in complete detail there will be presented a statement of the main requirements of an ideal system.

Salient Features of an Ideal System of Contract-Letting and Profit-Sharing.—The essential requirements of an ideal type of contract are as follows:

First.—It must provide a means of sharing with the workmen on an equitable basis the total net profit on the job.

Second.—It must set some kind of a limit to the total cost of the work, so as to prevent a careless or conscienceless contractor from running up the expense to an outrageously great amount.

Third.—It must reduce to a minimum the chance of the contractor's being out of pocket on the completion of the work, unless such condition is due to his own carelessness or lack of push.

Fourth.—It must retain all the advantages of competitive bidding, so as to give every capable and worthy contractor who is desirous of figuring on the work an even chance of securing the contract.

Fifth.—It must provide an incentive for the contractor and all his assistants and workmen to use every legitimate effort to make the work as inexpensive as possible, without violating in any manner the requirements of the specifications.

Mr. Waddell.

Sixth.—It must provide a just and equitable basis of payment for a possible increase in the estimate of total quantities and for adjusting satisfactorily to all concerned the reduction of payment due to a possible diminution thereof.

Seventh.—It must ensure that the owner will be acting for his own best interests by aiding the contractor in every possible way to complete his work quickly and inexpensively, provided, of course, that it is done in such a manner as to guarantee the attainment of the owner's ultimate purpose, as expressed in the specifications.

Eighth.—Its provisions must be such as to keep constantly in good humor every one connected with the construction.

Ninth.—Its method of final settlement of accounts must be clear, simple, and easy of application; and the keeping of them during the progress of the work must be no more complicated or expensive than it would be in the case of any ordinary "cost-plus" contract.

Description of the Ideal Method.—Let the specifications, which should invariably be drafted by an engineer who is acknowledged to be an expert in the class of work covered in the proposed contract, be complete and thorough in every detail, recording all that is known concerning the governing conditions; pointing out all features about which there is any uncertainty; tabulating as accurately as possible the estimated quantities of all the materials that will probably enter the construction; providing a justly drawn clause for unclassified work and the payment therefor; calling for each bidder to submit in full detail his estimate of actual cost of doing the work by applying to all quantities of materials given in the specifications, unit-cost prices (termed Schedule A), each price containing a proportionate share of any contingency allowance that may have been made, totaling the products so as to form "Sum A", and adding thereto the amount of profit which he has decided to ask, thus making "Sum B". This last amount will, in reality, represent the bidder's tender; but to it, if it is accepted, there will be added a profit for the owner, exactly equal to that asked for by the successful bidder, and another profit or bonus for the employees, amounting to a previously fixed percentage (say, 20 or 25) of the sum of the aforesaid profits of the contractor and the owner, thus making "Sum C". This last sum is the temporary limit of total expenditure on the part of the owner, based on the assumption that the approximate quantities of materials given in the specifications are correct. The ratio r of "Sum C" to "Sum A" is to be applied to each of the unit prices used in the preparation of the cost estimate, in order to obtain the list of unit prices (termed "Schedule B") to apply temporarily to the actual quantities of ma-

Mr. Waddell.

terials in the completed construction, when making the final adjustment of accounts.

If there are any items of expense of construction not covered by the list given in the specifications, the clause of the latter relating to "Unclassified Work" will take care of them. That clause should stipulate that, for all such unlisted items, the actual cost of labor and materials therefor, without any allowance for superintendence or overhead, is to be recorded; and to it is to be added later 30% of its amount to allow for superintendence, overhead, and the various profits. This sum is to be added to the total value of the actual quantities of all the materials listed in the specifications figured at the proportionately increased unit prices as given in "Schedule B"; and the result, "Sum D" (with a single modification explained hereinafter), will be the final limiting cost to the owner and the basis for computing the net profits to be divided between the contractor, the owner, and the workmen.

The specifications, of course, will contain a clause providing a surety company bond for the faithful performance of the work and for guaranteeing the client against having to pay more than the limiting sum agreed on (as finally modified).

Method of Profit-Sharing Contract.—The following method of profit-sharing between the contractor, the owner, and the employees is to be adopted:

An accurate estimate of cost of every detail of the work from start to finish is to be kept by the contractor and verified by an accountant in the employ of the client, so that the total profit on the job may be ascertained by deducting this total cost from the maximum figure named in the contractor's tender and afterward embodied in the contract (modified, however, as hereinafter described). This profit, less the amount of the employees' bonus, is to be shared between the contractor and the client as indicated in the profit diagram, Fig. 1. It should be clearly understood that every direct and indirect expense to which the contractor is put in doing the work, after the contract is signed, is to be included in the cost—all overhead expenses of every kind, plant deterioration, traveling expenses, supervision, and salaries, excepting only that the contractor himself is not entitled to any salary. In the case of a firm being the contractor, the head of that firm should receive no salary; but if any of the juniors devote their time exclusively to the job, it would be legitimate to allow them reasonable salaries, equivalent to what would have to be paid to regular assistants. All such matters, however, should be stipulated in the contract.

In order to determine, after the entire job is finished, the amount due the contractor, "Sum C" is to be subtracted from "Sum D", and the ratio which this difference (either a positive or a negative quan-

tity) bears to "Sum C" is to be figured and adopted in the use of the diagram of "corrective ratios" (Fig. 2) for the said difference. Mr. Waddell.

Application of Corrective Ratio.—There are two reasons for applying this corrective ratio;

First.—In the case where the actual quantities of materials exceed the estimated ones of the specifications, it would be hardly fair to the owner to apply to the excess those unit prices which produce his tentative limiting expenditure.

Second.—In the case where the actual quantities of materials are less than the estimated ones, it would be unjust to the contractor to use the high unit prices on the diminution quantities, not only because

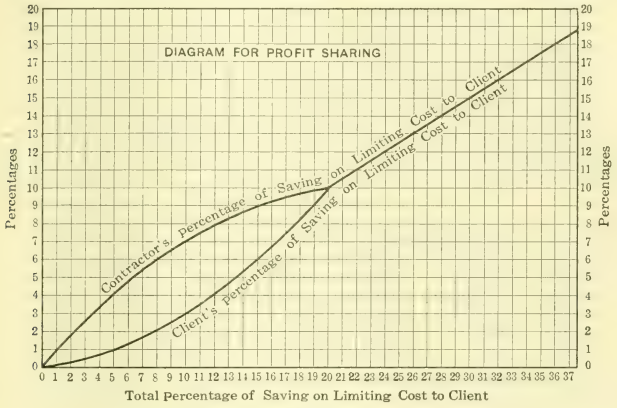
DIAGRAM FOR PROFIT SHARING
Contractor's Percentage of Saving on Limiting Cost to Client
Client's Percentage of Saving on Limiting Cost to Client
Percentages
Percentages
Total Percentage of Saving on Limiting Cost to Client

FIG. 1.

of the great difference between these and the unit actual costs, but, also, for the reason that the total overhead charges would be about the same for the diminished amounts as for the estimated total quantities.

In the corrective ratio diagram (Fig. 2), it will be noticed, that, after the ratio of value difference (due to increase or diminution of quantities of materials) reaches 0.2, the "corrective ratio" remains constant at 0.8, which corresponds approximately to actual cost conditions. The object of this is to provide that the contractor shall not be too much benefited by an abnormal increase in quantities, nor, on the other hand, shall he obtain too much advantage because of an abnormal diminution thereof.

Mr. Waddell.

To utilize the corrective ratio diagram (Fig. 2), look on the line of abscissas for the ratio of cost difference, pass vertically upward to the curve (or right line, as the case may be,) then horizontally to the extreme left vertical, which will indicate the corrective ratio required. Next, multiply the previously computed difference by this corrective ratio, and add the result to or subtract it from "Sum C". The result, "Sum E", will be the finally corrected limit, from which must be subtracted the total actual cost so as to determine the amount of

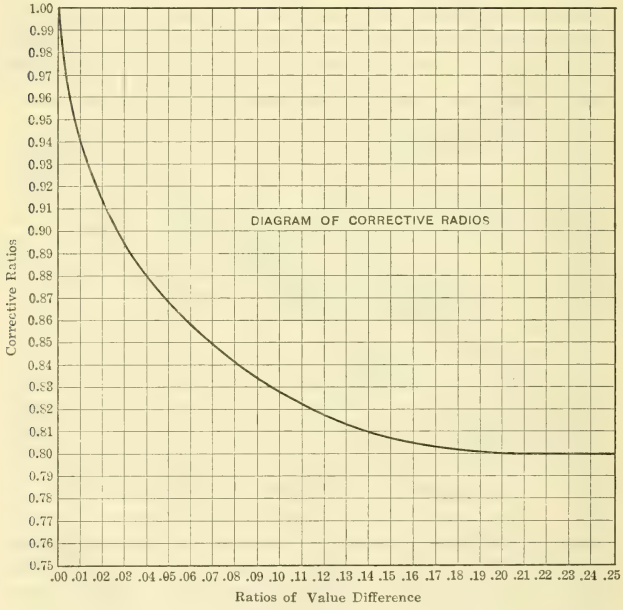

FIG. 2.

profit to be divided. The first step in such division is to set aside the employees' share on the basis of percentage agreed on; and the next is to divide the remaining profit between the contractor and the owner, as per the profit diagram (Fig. 1).

The size of the percentage of the declared profit to allow the employees will depend on the character of the work covered in the contract in respect to the proportionate division of the cost between materials and labor. Under ordinary conditions, the division is about half and

Mr. Waddell.

half, in which case the employees' percentage should be from 20 to 25; but where the labor cost preponderates these figures should be increased, and where the materials cost is the greater they should be diminished.

In respect to the division of this bonus among the employees, the following method is suggested:

Only those workmen or assistants of any class who have stayed on the job, either until its completion or until their services were no longer needed, should participate in the profits; and the amount of the share of each such workman and assistant should be in the proportion which his total earnings on the work bears to the grand total of the earnings of all those employees who so participate. As, in any good business organization, a record is always kept of the amount of salary or wages paid to each employee on any contract, it would require only a few hours of extra work for the bookkeeper, after the job is finished, to compute each man's proportionate share of the bonus.

There is an additional protection against possible loss which might be given to the contractor under certain conditions, especially on work to be done in a foreign country. If it be anticipated that during construction any large general rise in the price of labor is likely to occur, thus greatly augmenting the total cost of the work, the limiting total expenditure of the owner, as hereinbefore finally adjusted, should be increased by an amount figured thus:

Determine the average current wages for common labor at the time of letting the contract, and the average paid therefor during the entire time occupied by the construction, and call the ratio of these two averages r'; then figure the total amount of salaries and wages paid to employees from start to finish and call it W. Then,

$$W\ (r' - 1) \times 1.2$$

will be the amount required, the factor, 1.2, covering a fair allowance for overhead and profits.

It has been suggested of late in the technical press that the contractor himself should be paid a salary by the owner, in addition to whatever profit he may make on the job. Such a policy would be simply suicidal on the part of the owner, for if the work were to be handled badly, the contractor might continue to earn money while the owner would be losing heavily. The writer has met with just such a case; hence, in this particular, he certainly knows whereof he speaks. Such a practice should never, under any conditions, be countenanced by either the owner or his engineer.

Exemplification.—In order to illustrate the *modus operandi* of this method of profit-sharing, let us assume the following case, in which the estimated quantities are exceeded. For the purpose of

Mr. Waddell.

simplification in figuring, round numbers have been assumed for both the quantities of materials and the unit costs thereof. The job is one of railroad construction, and the number of items is intentionally limited for the sake of convenience.

The following are the quantities of materials supposed to be stated in the specifications:

Earthwork, measured in cutting.....	1 000 000	cu. yd.
Loose rock, " " "	100 000	" "
Solid rock, " " "	40 000	" "
Concrete in structures.....	10 000	" "
Wooden trestle	2 000	lin. ft.
Structural steelwork, erected.....	500 000	lb.

The tender of the successful bidder was as follows:

	Quantities.	Schedule A.	Totals.
Earthwork	1 000 000 cu. yd.	@ $0.50 =	$500 000
Loose rock.....	100 000 " "	@ $1.00 =	100 000
Solid rock	40 000 " "	@ $1.50 =	60 000
Concrete	10 000 " "	@ $20.00 =	200 000
Wooden trestle..	2 000 lin. ft.	@ $50.00 =	100 000
Steelwork	500 000 lb.	@ $0.08 =	40 000
Total estimated cost ("Sum A") =			$1 000 000
Profit required, 10% =			100 000
Tender ("Sum B") =			$1 100 000
Allowance for owner's profit =			100 000
Employees' profit, 25% of $200 000 =			50 000
Temporary limit ("Sum C") =			$1 250 000

$$\text{Ratio, } r = \frac{\text{Sum } C}{\text{Sum } A} = \frac{\$1\,250\,000}{\$1\,000\,000} = 1.25.$$

The proportionately increased unit prices, therefore, will be as follows:

	Schedule B.
Earthwork	$0.50 × 1.25 = $0.625
Loose rock.....	$1.00 × 1.25 = $1.25
Solid rock.....	$1.50 × 1.25 = $1.875
Concrete	$20.00 × 1.25 = $25.00
Wooden trestle.....	$50.00 × 1.25 = $62.50
Steelwork	$0.08 × 1.25 = $0.10

Mr. Waddell.

The actual quantities of the materials in the completed job were, as follows:

Earthwork	980 000	cu. yd.
Loose rock	110 000	" "
Solid rock	50 000	" "
Concrete	10 500	" "
Wooden trestle	2 100	lin. ft.
Steelwork	480 000	lb.

In addition, there was done by the contractor certain "unclassified work" which actually cost him for labor and materials $20 000.

The revised estimate is, therefore, as follows:

Earthwork	980 000	cu. yd.	@	$0.625 =	$612 500
Loose rock	110 000	" "	@	$1.25 =	137 500
Solid rock	50 000	" "	@	$1.875 =	93 750
Concrete	10 500	" "	@	$25.00 =	262 500
Wooden trestle	2 100	lin. ft.	@	$62.50 =	131 250
Steelwork	480 000	lb.	@	$0.10 =	48 000
Unclassified work	$20 000	× 1.3 =			26 000
Summation, or "Sum D"				=	$1 311 500

The difference between "Sum D" and "Sum C" equals

$$\$1\,311\,500 - \$1\,250\,000 = \$61\,500.$$

$$\text{Ratio of difference} = \frac{\$61\,500}{\$1\,250\,000} = 0.0492;\ \text{say, } 0.05.$$

For this ratio, the diagram, Fig. 2, gives a corrective ratio of 0.865. which multiplied by $61 500 gives $53 198, say, $53 200, making the corrected limit, or "Sum E", = $1 250 000 + $53 200 = $1 303 200.

If the total actual cost of the work, including that of the unclassified work without allowance for superintendence or overhead, amounted to $1 100 000, the total profit would be:

$$\$1\,303\,200 - \$1\,100\,000 = \$203\,200.$$

Of this, the joint share of the contractor and the owner would be:

$$\$203\,200 \div 1.25 = \$162\,560;$$

and the employees' bonus would be:

$$\$203\,200 - \$162\,560 = \$40\,640,$$

which is exactly 25% of $162 560.

In respect to the division of this last amount between the contractor and the owner, its ratio to total cost is:

$$\$162\,560 \div \$1\,100\,000 = 0.148, \text{ or } 14.8\%.$$

Mr. Waddell.

From the diagram for profit division (Fig. 1), we find the division of this percentage to be:

Contractor	8.9%
Owner	5.9%

This makes the total payment by the owner to the contractor:

$$\$1\,100\,000 \times 108.9 = \$1\,197\,900$$

Let us now take a case where there is a diminution in the estimated quantities of materials. Using the same case as before in respect to estimated quantities and tender, we shall assume the following actual quantities of materials:

Earthwork	1 050 000 cu. yd.
Loose rock	50 000 " "
Solid rock	20 000 " "
Concrete	8 000 " "
Wooden trestle	1 800 lin. ft.
Steel work	450 000 lb.

The cost of the unclassified work was $20 000, as in the preceding case.

The revised estimate is, therefore, as follows:

Earthwork	1 050 000 cu. yd.	@	$0.625 =	$656 250
Loose rock	50 000 " "	@	$1.25 =	62 500
Solid rock	20 000 " "	@	$1.875 =	37 500
Concrete	8 000 " "	@	$25.00 =	200 000
Wooden trestle	1 800 lin. ft.	@	$62.50 =	112 500
Steelwork	450 000 lb.	@	$0.10 =	45 000
Unclassified work	$20 000 × 1.3 =			26 000
Summation, or "Sum D"			=	$1 139 750

The difference between "Sum D" and "Sum C" equals

$$\$1\,139\,750 - \$1\,250\,000 = -\$110\,250$$

$$\text{Ratio of difference} = \frac{\$110\,250}{\$1\,250\,000} = 0.0882$$

For this ratio, the diagram gives a corrective ratio of 0.835, which, multiplied by $110 250, gives $92 059, say, $92 100, making the corrected limit,

$$\text{"Sum E"} = \$1\,250\,000 - \$92\,100 = \$1\,157\,900.$$

If the total actual cost of the construction, including that of the unclassified work without allowance for superintendence or overhead, amounted to $880 000, the total profit would be:

$$\$1\,157\,900 - \$880\,000 = \$277\,900.$$

Mr. Waddell.

Of this, the joint share of the contractor and the owner would be:

$$\$277\,900 \div 1.25 = \$222\,320,$$

and the employees' bonus would be:

$$\$277\,900 - \$222\,320 = \$55\,580,$$

which is exactly 25% of $222 320.

In respect to the division of this last amount between the contractor and the owner, its ratio to total cost is:

$$\$222\,320 \div \$880\,000 = 0.253, \text{ or } 25.3\%.$$

From the diagram for profit division, (Fig. 1), we find the division of this percentage to be on the "fifty-fifty" basis, making the total payment by the owner to the contractor = $880 000 × 1.1265 = $991 320.

Advantages.—The advantages of this method of contract-letting are as follows:

First.—While it is true that the client at the outset does not know exactly what the work is going to cost him, he is positive that it will not cost him materially more than a certain amount, provided his engineer's estimate of quantities is about right, as, generally speaking, it certainly ought to be.

Second.—The client has the satisfaction of feeling that even if, in his opinion, the limit determined by the contractor's bid is excessive, and that the final net profit on the job, in consequence, will be too large, the said net profit will be shared between them on a "fifty-fifty" basis.

Third.—While the client is bound to pay a certain percentage of the joint profit as a bonus to the contract's employees, generally he will not be out of pocket thereby, but, on the contrary, he will gain; because the incentive that the prospective bonus gives to all hands to labor energetically will save in the total cost much more than the amount of the bonus.

Fourth.—All the advantages of competitive bidding are retained by this method, because the fully capable competitor who tenders the lowest amount for "Sum B" should be awarded the contract. All bids will be on exactly the same basis, no modification of the stipulated method of tendering being permitted. It is understood, of course, that the contract will not be awarded to any competitor who does not possess the necessary experience, capital, and plant, and who has not an established reputation for doing good and satisfactory work.

Fifth.—The contractor, if he was not too keen in bidding, knows that there is almost no chance whatsoever of his losing money on the job; because before doing so he would have to use up his allowance for contingencies, his own estimated profit, a profit of like amount

Mr. Waddell.

allowed for the owner, and a substantial sum representing the employees' bonus. If he ever does use up all these safeguards, the chances are many to one that the fault therefor is entirely his own, being due to his negligence, lack of forethought, or deficiency in energy and push; and in that event he certainly would deserve to be penalized.

Sixth.—All the workmen and salaried employees of the contractor will be satisfied with their job because of the excellent opportunity offered for extra compensation; and they will, of their own accord, work diligently, and occasionally even overtime, in order to expedite the construction. Of their own accord, too, they will run off the job any employee who is a chronic shirker, and they will make it their business to keep everybody busy; because the more cheaply the construction is done the greater will be the bonus to divide among the faithful employees who stick by the work to the finish.

Seventh.—The method of profit-sharing given by the diagram for profit division (Fig. 1), is eminently equitable, in that when the net amount is small, nearly all of it goes to the contractor, and, as it augments, a continually increasing proportion of it goes to the owner, up to the point where the total joint profit amounts to 20%, after which the partition is on a "fifty-fifty" basis.

It will be seen that for a total net joint profit of less than 20%, the following divisions will prevail:

With 5% net, 4% goes to the contractor and 1% to the owner
With 10% net, 7% " " " " " 3% " " "
With 15% net, 9% " " " " " 6% " " "

The 20% point was selected for equal division as being the one above which a contract is generally deemed by contractors to be good, slightly below which it is only fair, and much below which it is bad; for it corresponds to a net profit of 10 per cent. That is as small a margin as is generally deemed safe for any bidder to tender upon, and yet it constitutes a satisfactory profit on a finished job. As for limiting the client's share of the profit to one-half—that is reasonable and just, because he would have no moral right to receive more than his partner, the contractor. If the client's share were allowed to increase indefinitely, it is conceivable that, with a very large prospective total profit, the contractor could save money for himself by making the work more expensive.

Any bidder who tenders on the basis of a profit less than 10% should be looked on askance by the owner and his engineer; and such a competitor should not be awarded the contract, unless he possesses an exceptionally fine reputation for doing good work and for not quitting his job before finishing it. It is true that during

very hard times many worthy contractors are willing to work almost for actual cost, in order to keep their workmen employed; and in such cases the good intention should be recognized in making the award. Nevertheless, it nearly always proves to be unsatisfactory to both the owner and his engineer to let a contract for any piece of construction at a figure below its real value. Mr. Waddell.

Eighth.—The contractor will feel during the progress of the construction that the client is a partner on the job, and that, therefore, he and his engineers will not be likely to be unnecessarily severe in their requirements, also that they will permit the adoption of all legitimate expense-saving expedients, and will not demand too many frills on the finishing.

Ninth.—Owing to the justice and equity involved by this method of contract-letting and profit-sharing, all concerned in the execution of the work will labor whole-heartedly and good-naturedly, avoiding petty squabbles and disagreements; and the result will be earnest, honest effort, a satisfactory piece of construction, and the general contentment of both parties to the agreement.

Tenth.—While this method may at first glance have the appearance of being complicated, it is quite simple; and because of the clear manner in which it is explained herein, it is easily utilized in any actual case by following one step at a time the directions given. The nomenclature of "sums" and "schedules" renders the application of the method very easy. Moreover, it must be remembered that it is to be used only once for each contract, and then only after all the work is completed and the accounts are in proper form. Again, the keeping of the accounts is in no way any more complicated than it would be in case any of the "cost-plus" methods were used.

Objections That Have Been Raised to This Method.—A few objections, both orally and in print, have been raised to this proposed method of contract-letting and profit-sharing; but they could not have been well considered, for they are not valid. It will be well before closing this discussion to mention them and show wherein they are untenable. They are as follows:

A.—It has been asserted that there would be special difficulty in keeping the accounts; but there would be required therefor exactly the same work which would be necessitated by any of the "cost-plus" methods. They all involve a correct record of the amount of every legitimate item of expense to which the contractor is put; and the bookkeeping in any case would certainly require an account with each employee, so as to show how much money had been paid him from start to finish.

B.—It has been claimed that the method is too complicated to be useful. On the contrary, as explained previously, it is simple; and the peculiar manner of its presentation herein is such as to render

Mr. Waddell.

its use merely a matter of following step by step certain clearly written instructions. Moreover, as before indicated, this method of settlement of accounts is used only once, *viz.*, after the completion of the job.

C.—It has been stated that uneducated contractors would have difficulty in understanding the method; but the man who made this claim did the average American contractor a grave injustice. The construction contractors in this country are as bright a body of men as one can find anywhere; and certainly they may be trusted to understand anything in reason that affects their interests.

D.—It has been claimed that most contractors have a general inherent objection to sharing profits with the owner; but a little consideration will show that there is no sharing of the requested profit until after the estimated cost of the work (under the assumption of unchanged quantities of materials) has been exceeded. It was to clarify this situation that the writer changed his original idea of having each bidder name a lump-sum (corresponding to "Sum C") as a provisional limit of the owner's total expenditure, and a list of unit prices (corresponding to "Schedule B") which, when applied to the estimated quantities of the specifications, would make the sum of the products exactly equal to the said lump-sum, and substituted therefor the method herein described, *viz.*, that of having each bidder submit in detail his estimate of cost and his desired profit, so as to base the competition on the sums thereof thus tendered, and arranging the method of determining the limiting cost to the owner by two additions to the successful bidder's total tender. This change is simply a concession to prejudice, and does not modify the method proposed by the writer in his letter published in *Contracting* in its issue of September 15th, 1919. The only fundamental change between that presentation of the matter and this one is the inclusion herein of a bonus for the employees.

E.—It has been claimed that this method would tend to deceive the owner. He would certainly be stupid if he could not see clearly how its tendency is to cut down the amount that he will pay for the entire work, and that it will set a just limit beyond which, under the worst possible conditions, he cannot be compelled to pay any more.

F.—It has been stated, as a reason for favoring the "cost-plus" system, that bonding companies favor it and oppose all other methods of contract-letting. Naturally, they would do so; because, with the "cost-plus" method, their obligation reduces almost to zero, the risk being placed solely on the owner. In truth, with that method adopted, there does not appear to be any valid reason for having a bond at all. When the contractor runs no risk of loss whatsoever, why a surety company bond? Possibly, if the surety companies would consider it from this point of view, they would not oppose the writer's suggested method of

contract-letting; for, while it reduces very greatly the possibility of loss to the surety company, it does not destroy that organization's function by removing entirely its *raison d'être*. Mr. Waddell.

G.—The claim has been made that this method is not applicable to cases where no estimate of quantities has been made or for which no specifications have been prepared, and when it is necessary to let the work without delay. The correctness of this claim is granted, but its applicability should be confined to war work, in which the element of time is the principal consideration. In civil life, if a projector of an enterprise is in such haste to start his work that he has to omit the preparation of specifications and estimates of quantities before letting the contract, he certainly deserves what is coming to him in case it proves that he has placed himself in the hands of an unscrupulous contractor on the "cost-plus" basis.

H.—It has been pointed out that the law will prevent certain public bodies from letting contracts on a "cost-plus" basis, and that such a ruling might apply to the writer's proposed method also. If such really is the case, the remedy would evidently be to modify the law so as to permit of its adoption; but would not the fact of its containing a clause which sets a limit to the contractor's total compensation always render the method legal? This, however, is a question for the lawyers to settle.

I.—A prominent writer on economics has lately issued a tirade against gambling, especially as it applies to contractors guaranteeing owners against the cost of work exceeding the amount of the tender. The writer concurs in this theory to the extent that there should be no gambling on the amounts of assumed quantities of materials, or, in certain cases, on there not being any great rise in the average price of labor, or on possible loss through any reasonably great amount of hard luck; but there is certainly nothing unmoral or oppressive in insisting on his gambling to the extent of guaranteeing against his own incompetency, carelessness, or lack of forethought. The writer is of the opinion that a margin against actual money loss to the contractor, consisting of his estimated amount for contingencies, plus his requested profit, plus an equal profit for the owner, plus a substantial bonus for the employees, is amply large to guarantee him against all loss through ordinarily unfavorable eventualities; and that, in ninety-nine cases out of a hundred, if such a margin were exceeded, it would be because of the contractor's own fault.

Adoption of Method.—If this proposed method of contract-letting and profit-sharing is received with favor by engineers, architects, contractors, and builders in general, it could easily be adopted as a standard for the country by calling a small convention with a single representative from each of the leading technical and railroad societies,

Mr. Waddell.

contracting organizations, bankers' associations, and labor guilds, to discuss the advisability of adopting it (or else some modification of it) and to report the decision of the meeting to the said bodies for their approval. If any large group of clients, such as the railroad companies, were to adopt the method as standard and use it, very soon everybody having construction contracts to let would follow their example, thus making it the universal standard of contract-letting for the country—nor would it be long before other American countries would follow our lead, thus greatly simplifying our business relations with the various American Commonwealths.

Addendum.—In all lines of manufacture the employees should share in the net annual profits of the company; but, in figuring the yearly cost of running the establishment and doing the work, there should be included fair salaries for all the working officers, 6% on the actual amount of cash invested in the plant and business (but not on the total capital stock), an annual allowance for a sinking fund to redeem the bonds or other indebtedness of the organization, and taxes of every kind. The net profit estimated in this way should generally be divided on the basis of one-third to the employees and two-thirds to the company, but sometimes, perhaps, on that of one-fourth and three-fourths. The reason why it should not be split on a "fifty-fifty" basis is that the company has to run the risk of standing a loss in bad years, while the employees do not. Only those employees who are still connected with the company at the end of the year, or who have been discharged in good standing, should share in the bonus; and their proportionate amounts should be computed as previously indicated for the case of construction contracts.

AMERICAN SOCIETY OF CIVIL ENGINEERS
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PAPERS AND DISCUSSIONS

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THE SILT PROBLEM OF THE ZUNI RESERVOIR

Discussion*

By Elwood Mead, M. Am. Soc. C. E.

Mr. Mead.

Elwood Mead,† M. Am. Soc. C. E. (by letter).‡—This paper deals with the most serious problem of water conservation in the arid Southwest. The author shows that the Zuni Reservoir which cost $500 000, has lost six-tenths of its capacity in 12½ years, that the reservoir near Carlsbad, N. Mex., has lost more than half its capacity in 15 years, and that, in a few years more, both these basins will be mud-flats of no value for irrigation.

The same menace confronts nearly every reservoir built in the channel of streams in the southern half of the arid region. The Rio Grande River at times carries so much silt that it runs in waves, like the tailings away from a stamp-mill. In its channel, and in those of other sediment-laden streams, great reservoirs have been built, and millions of dollars have been or are being spent on irrigation channels, clearing, leveling, and draining lands, building houses, and planting orchards. The benefits to come from all this endeavor and expense depend on the water supply being permanent, on the storages being maintained to practically their full capacity. Every one knows that, unless some plan of desilting is devised and put into operation soon, this will not be the result, and that the life of all these storages will be comparatively brief.

These great undertakings are examples of the happy-go-lucky practice of acting first and thinking afterward; of refusing to see things that are disagreeable. The people of the Southwest wanted irrigation;

* This discussion (of the paper by H. F. Robinson, Assoc. M. Am. Soc. C. E., published in August, 1919, *Proceedings*, but not presented at any meeting) is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

† Berkeley, Cal.

‡ Received by the Secretary, September 25th, 1919.

Mr. Mead. they wanted the deserts made green, but they were not willing to wait until some feasible plan of desilting was worked out. The water was needed; the immediate results would be good, let the future and the people who would buy these farms, take care of themselves.

The conservation of water for irrigation and power purposes stands on an entirely different footing in the northern and southern halves of the arid region. In the northern half, reservoirs can be placed in the channels of running streams and endure. The silting process is so slow that the cost of removing the sediment, if it ever became necessary, would not be prohibitive. This is shown by the fact that the natural lakes in the streams of this region have been there for unnumbered centuries without being filled or greatly reduced in area by silting. Yellowstone Lake in the channel of Yellowstone River, Jackson Lake in the channel of Snake River, Fremont and Wind River Lakes in the tributaries of Green River, Lake Tahoe in the channel of the Truckee River, and Klamath Lake in the channel of the Klamath River, are illustrations of conditions that make reservoirs a safe basis for both agriculture and power development in practically all the region north of Arizona and New Mexico.

South of this region, there are no natural lakes in the channels of streams. The heat, the aridity, and the torrential character of the rainfall, are friends of erosion, and help to explain the high percentage of silt which these streams carry at certain seasons. To build storages in these channels, in the absence of some definite plan for insuring their permanance, ought not to continue. It is one of the matters which ought to be investigated, and one in which actual conditions in all existing reservoirs ought to be known and published, in order that this menace may be faced and, if possible, some plan worked out of averting the danger. Mr. Robinson has rendered a service to the whole country by publishing the facts.

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PAPERS AND DISCUSSIONS

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PHYSIOGRAPHY OF WATER-SHEDS AND CHANNELS, AND ANALYSIS OF STREAM ACTION OF SOUTHERN CALIFORNIA RIVERS, WITH REFERENCE TO THE PROBLEMS OF FLOOD CONTROL

Discussion*

BY MESSRS. CHARLES A. POHL, FRANCIS H. WRIGHT, AND H. F. DUNHAM.

Mr. Pohl.

CHARLES A. POHL,† M. AM. SOC. C. E.—Attention is called, on page 468‡ of the paper, to observations by Mr. G. O. Newman, in 1892, on the Santa Ana River, which show that deposits in the river bed were in motion to a depth of 15 ft.

Observations on other rivers show that scour of the river bed may extend to even greater depths. In a report by the late James B. Eads, F. Am. Soc. C. E., on the St. Louis Bridge, he states:

"Soundings made by me prove that this deposit is scoured out to a great depth in time of floods and freshets. Although I have not had any extreme stage of water in which to make my observations, I found that a rise 13 ft. less than high-water mark caused a scour of 18 ft. The greatest variation in the height of the river known at this place is about 41 ft. * * * The concentration into this narrow channel of the vast volumes that are sometimes poured out of the gigantic net-work of streams above St. Louis, the main artery alone of which is navigable over a thousand leagues above this city, assures me that in time of floods it is not improbable that this deposit is removed to twice or thrice the depth shown by my soundings, and perhaps to the rock itself."

* This discussion (of the paper by A. L. Sonderegger, M. Am. Soc. C. E., published in August, 1919, *Proceedings*, and presented at the meeting of October 1st, 1919), is printed in *Proceedings* in order that the views expressed may be brought before all members for further discussion.

† New York City.

‡ *Proceedings*, Am. Soc. C. E., August, 1919.

Mr. Pohl. The rock under the westerly pier of the Eads Bridge is 55 ft. below high water; under the second pier, it is 99 ft., under the third, 127 ft., and under the fourth pier, at the easterly side of the channel, 135 ft. below high water. At the center of the middle span, the low-water depth of the river was about 15 ft., and the depth from the river bed at the same point to rock at low-water stage was 60 ft. Under the center of the easterly span, the low-water depth was 15 ft. and the depth from the river bed to rock about 80 ft. As Capt. Eads' observations were made presumably at the bridge site, they would indicate a scour of four and possibly five times the low-water channel depth.

The extent of the erosion of the banks and bed of the Mississippi River is enormous. The following data are taken from a Report by a Special Board of Engineers on Survey of Mississippi River:*

"AVERAGE ANNUAL AMOUNT OF CAVING ON BOTH BANKS, MISSISSIPPI RIVER, CAIRO TO DONALDSONVILLE.

Locality.	AREA.	HEIGHT FROM RIVER BOTTOM TO TOP OF BANK.
	Square yards.	Feet.
Cairo to Memphis	6 112 000	53
Memphis to Helena	2 978 000	47
Helena to Arkansas City	4 137 000	62
Arkansas City to Vicksburg	12 024 000	67
Vicksburg to Natchez	9 371 000	76
Natchez to Red River	3 106 000	73
Red River to Donaldsonville	1 263 000	84
Total	38 991 000	66*

* Annual average.

* * * * * *

"Similar measurements were made during the present year (1908-09) as to the extent of caving banks on the river between Cairo and St. Louis, by which it was shown that the volume of earth falling into the river from that reach averaged annually 64 000 000 cu. yd. from 1879-1889; nearly 48 000 000 cu. yd. from 1889-1899; and about 49 500 000 cu. yd. from 1899-1907, the diminution of such caving in the last eighteen years evidenced thereby being considered due to the extensive revetments that were built along this reach between 1881 and 1905.

"Experiments conducted in 1879 under the direction of the St. Louis U. S. Engineer Department at the mouth of the Missouri River to determine the amount of sediment coming into the Mississippi River from the Missouri above St. Louis (p. 1653, Annual Report, Chief of Engineers, 1881, and p. 3090, Annual Report, Chief

* Document No. 50, 61st Congress, 1st Session.

of Engineers, 1887), showed that the floating sediment alone, resulting from caving banks in the Missouri itself, amounted to 187 000 000 cu. yd. during nine months of the year. As these observations took no account of the heavier matter in the foot of depth nearest the bottom, nor of the solid material (such as sand or gravel) driven along the actual bed of the river by its currents, Col. Suter considered it safe to assume that fully 400 000 000 cu. yd. of material then came out of the Missouri River in twelve months. It is probable that at least the same amount of material is still coming out of the Missouri River at the present time. Other observations by the U. S. Engineer Department and the Mississippi River Commission indicate an outflow of sediment and rolling material of about 36 000 000 cu. yd. per year from the Ohio River, about 5 000 000 cu. yd. per year from the Arkansas River and about 6 000 000 cu. yd. per year from the Red River. Mr. Pohl.

"By the above showing, the amount of material originating from caving banks which the Mississippi River, between St. Louis and permanently deep water in the river below Donaldsonville, must carry along and dispose of every year, amounts to more than one and one-fourth billion cubic yards."

One of the factors in the adverse report by a Special Board of Engineers on the improvement of the Mississippi River between St. Louis and Cairo, by means of two large dams—one at Jefferson Barracks just below St. Louis, and the other near the Thebes Bridge, about 40 miles above Cairo—was that the filling up of the pools above the dams would inevitably take place.

An estimate was made by the Board that dredging of from 100 000 000 to 400 000 000 cu. yd. of material would be required each year to prevent the filling up of the channel above the dams and the floods and other damage resulting therefrom.

The Tennessee River does not carry a heavy load of silt. Its banks are very stable, and very little caving and erosion occur along the main stream which has a length of about 215 miles above the Hales Bar Dam, near Chattanooga, to the head of navigation at Knoxville, and a drainage area of about 29 000 sq. miles at the dam. The material carried is nearly all in suspension and presumably comes from the smaller tributaries 100 miles or more.

In 1918, fields of corn were under cultivation above this dam on land which was under low water when the dam was completed in 1913.

The raising of the river bed by several feet in 5 years shows what may be expected where the velocity of a river carrying soil in suspension is lessened by the construction of a large dam.

FRANCIS H. WRIGHT,* ASSOC. M. AM. SOC. C. E.—The losses caused by erosion along the Mississippi River are something which erosion has also built up again, that is, the eroded material becomes alluvial as it is restored by deposit along the lower reaches. The speaker does Mr. Wright.

* New York City.

Mr. Wright.

not believe that, if the quantity of eroded material is set against the quantity restored along the lower river, any great change will be found in the adjacent geology within the span of a life time. He believes that the great quantity that is carried out of the mouth of the Mississippi is that which originally came from the upper reaches of the Missouri River, or from the Ohio River, especially the former.

The gradient of a stream near its source in the hills begins as a convex curve which gradually changes and becomes concave, ending in a tangent at its base or at sea level. The convex gradient is one of irregular steep slopes making rapid velocity, with great scouring and conveying capacity. The concave gradient of more uniform slopes is characterized by their flattening with approach to base level, with reduction in the average velocity, and tendency of the stream to deposit its burden. This tendency is apparent immediately following periods of flood.

The section of a stream within and below the elevation of what is commonly known as "bank full" stage can be defined as a normal section. Equal velocities through equal sections will convey equal volumes in equal periods of time. Variations in velocity, however, do not function with variations that exist in the normal section and the volume of discharge of a stream. The normal section along the concave gradient becomes abnormal during flood, through the overflow, and the previously mentioned variables are thereby harmonized. Unless confined, the section becomes greatly increased, with a consequent reduction in the average velocity and carrying capacity. Subsidence brings a further reduction in velocity, and the stream returns to its normal section within its banks. These reductions in velocity at a time when the stream is most charged with suspended matter, show the greatest amount of deposit. This is especially apparent over the overflowed area just after subsidence. The removal of material from along the upper reaches of a stream to its deposit along the lower reaches is a natural result from the character and variation in its gradient. The Mississippi being very flat and alluvial in its delta region, it follows that its gradient at that point is a concave curve.

The condition described in Mr. Sonderegger's paper, as the speaker has been able to understand it, is a more difficult problem of flood control than that of the Mississippi, even though of lesser magnitude.

These Southern California rivers pass suddenly from steep slopes in rock-lined canyons through débris cones of unknown density and doubtful stability to an alluvial valley with flat slopes. These cones, accumulated through ages, are located where the stream section readily becomes abnormal and where the velocity suddenly decreases.

Among the requirements which the author considers as the solution of this problem is that of absorption on the débris cone of the peak

flood load. This implies the use of storage reservoirs. The speaker can imagine that it would be quite difficult to hold this water on these cones. It appears possible for it to escape, not only through absorption, but by breaking through the cone at some lower elevation and seeking a new channel to the sea. If the escape is only through absorption within the débris cone, the seepage arising therefrom in the lower valley would have to be considered. Mr. Wright.

Some of the effects of high water which the speaker has observed along the Lower Mississippi have led him to believe that full storage reservoirs would cause all the adjacent soil to become saturated. A continued rainy period, added to a full reservoir, would furnish more potential danger than without the reservoirs.

With reference to the previous remarks about the erosion along the Lower Mississippi, the speaker does not wish to convey the impression that he considers it as insignificant. It is very great, but it is balanced by the replacement which is also very great. During the past ages, the latter has exceeded the former, or there would be no alluvial valley to-day. The sum total of material that passes the mouth of the Mississippi River into the Gulf of Mexico will balance the quantity derived from the region tributary to the convex gradient of that river or its feeders, less the increment in the lower alluvial valley.

As to actual erosion, one instance is recalled where a plantation (the Bondurant Plantation in Tensas Parish), in Louisiana lost nearly 1 700 ft. of receding caving bank during one year. This distance was taken along a line at right angles to the axis of the channel at that place and was measured from actual surveys. A few miles down stream, a sand-bar was built up, which was probably of sufficient volume to offset that which was taken from this plantation. That which is taken from one side is restored on the opposite side, etc. The silt is deposited, picked up, carried further, again deposited, etc., during the different years of its journey from its origin to its final deposit or to the sea.

J. A. Ockerson, Past-President, Am. Soc. C. E., has made a report* concerning surveys undertaken to estimate the amount of erosion through caving banks along the Mississippi River. These surveys were made in 1891-92 along caving bends between Cairo, Ill., and Donaldsonville, La. The survey of 1879 of the Mississippi River Commission between Cairo and the Passes was a thorough topographical and hydrographical survey which included the areas resurveyed, and an accurate estimate was made from the sections produced between the two surveys.

The estimate given in that report shows that the annual erosion between Cairo and Donaldsonville amounts to a volume 66 ft. in

* Annual Report of the Chief of Engineers, U. S. A., 1892, Pt. 4, p. 3111.

Mr. Wright.

depth, over an area of 9½ acres for each mile of river, or, for the total length of river included by the survey, a volume of 86 ft. in depth over 10 sq. miles of area. This estimate only refers to the quantity eroded and makes no allowance for quantities deposited on banks or in the channel.

Mr. Ockerson mentions a fill near Commerce, Mo., about 2 000 ft. wide and about 5 miles long, which was under cultivation at that time (1891), but which, in 1879, was occupied by the river and outside of a caving bank. The large quantity of erosion referred to in Mr. Ockerson's report might have originally started in Wyoming or Montana and probably required some hundred years to reach the Lower Mississippi, perhaps less, but a long time.

It is said that, in the distant past, the mouth of the Mississippi River was at about the present location of Cairo, Ill., and that there it entered the Gulf of Mexico. The region to the south, which is commonly known as the delta, has been built up through alluvial deposits since that time.

The construction of a concrete warehouse for an unloading wharf on the Mississippi River, on which the speaker was engaged, required pile clusters, heavily loaded, to support the concrete footings. A sheet-piling enclosure surrounded the site, and after the clusters were driven, a sand filling was pumped in, surrounding the clusters to the elevation of the bottom of the concrete footings, and serving as a base for them during construction. At extreme low water, or while the sump pumps were active, a crust formed over this fill, which was able to carry a heavy load and on which one could walk. A 70-ft. pile dropping from the driver leads would not "take up" for 30 or 40 ft. in the silt below. Piling in place and projecting 5 or 6 ft. above the crust vibrated very perceptibly from a good lusty kick. This sand filling had been placed during an interval of perhaps two years from the placing of these piling clusters until it was practicable to pour the concrete footings.

In checking the positions of the piles in the clusters for errors in their centers of gravity and their correction, the speaker observed that many of them were much inclined from the perpendicular and symmetrical in the amount of their inclination and in its general direction. It was surprising to discover that the pitch from the perpendicular of some of the piling was 3 in. and more to the foot of length, or a lean in a 70-ft. pile of about 18 ft. It was realized that the design load could not be applied under these conditions, as the piling would bend through the soft silt to complete failure. A careful survey was made with a plumb and rule, and those piles which deviated beyond the adopted limit were cut out and others driven. The symmetrical inclination was attributed to a movement of the sand filling toward the channel of the river.

It is the speaker's opinion that movement of a culvert is possible through inclined piling in a soft soil. Inclined piling has been driven and properly capped to receive thrusts without bending in the piles and has been satisfactory. Where compensation against bending is not provided, or cannot be given, the consequences are apt to be uncomfortable to say the least. Mr. Wright.

H. F. Dunham,* M. Am. Soc. C. E.—The profile of the Susquehanna River could be cited as being unlike any of the profiles referred to by the author. The grades coincide or are approximately regular until the flattening out would indicate a near approach to sea level, and then the river drops more than 200 ft. in about 40 miles, or a comparatively short distance. This occurs in a region where uplifts and vibrations are rare instead of frequent. It has not been shown that the condition is due to glacial action. Mr. Dunham.

Two or three statements in this interesting paper may seem worthy of further comment or of explanation by the author. His graphic description of débris cones is appreciated by the speaker who has had little opportunity to see them and none at all to study them. In ignorance, too, of California practice, any detail of the method used to determine the percentage of seepage at the higher or lower sections of a débris cone would be of interest to him, especially as the distance between the points of variation are well within ten miles, and the formation throughout is the result of moderately uniform natural causes.

Except for some subtle condition not understood, the speaker would say that the more an aggregate differed from one that ought to be used for concrete, the better seepage bed it would be where large additions to the ground-water were desired. The weight of the material composing the aggregate might be given in terms of specific gravity of the rock formations from which it was derived, whether in part volcanic ash or tufa.

On page 467†, requirements for the effective control of floods on the débris cone are mentioned. They comprise elimination of the rolling débris and the larger part of the suspended matter when the water reaches the mouth of the canyon; and it is also required that flood water so deprived of its burdens shall not take up new material or erode its bed and banks on a grade of 50 ft. to the mile. What agency can make this possible? Where on the steep slopes and mountain sides are reservoirs to be provided above the canyon for flood control? If provided, how quickly would they be filled with débris and become useless?

A section of the profile of the Westfield River, in Massachusetts, compares fairly well for grade with the débris-cone channel section

* New York City.

† *Proceedings*, Am. Soc. C. E., August, 1919.

Mr. Dunham.

(Fig. 2), shown by the author. The area above comprises about 90 sq. miles. Rocks, granite, gneiss, and micaschist are present; and a small quantity of slate is also present. The precipitation measures about 40 in. per annum, more nearly uniform per month, by the average of many years, than can be found in many sections of the United States. Downpours of 3 or 4 in. in 24 hours have been observed, and, in addition, there are heavy snows and thick ice, in the annual freshet period. At times of such floods, the depth of the water ranges from 15 to 20 ft., or more, above low water. The river flows over glacial deposits of boulder clay in many places. The river bed is never quite dry, but extremely few areas are covered with sand. At rare intervals there have been days when no current was visible. It is a river bed of stones, with boulders up to many tons in weight, and rather uniformly distributed, that is, big boulders are not appreciably more common or numerous at the upper than at the down-stream end of the cone section. The ice is a carrier, as it is

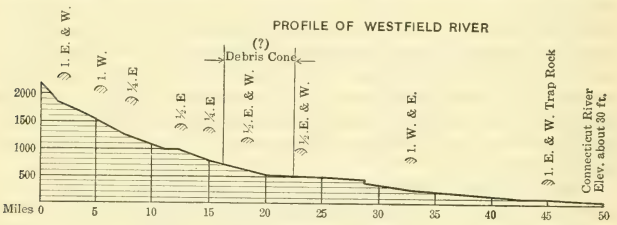

FIG. 9.

often frozen to the boulders and stones, and more often bowls them along. At sharp turns in the channel, there may be depths of water of from 5 to 15 ft., measured from the low-water mark, and, in such holes, the scour at flood and the re-filling would be noticeable, but all within a very few feet; it might be nearer the truth to say a very few inches. Over or on the surface of the river bed, there is a slow average movement of the stones and boulders down stream, but a movement of such material to a depth of 2 ft., or even 1 ft., below low-water mark, would be contrary to all observations unless it could be shown that at flood time the material at a depth of "15" ft. was moving down stream, while the river bed remained in place. If given in detail the observations of Mr. Newman, mentioned under "The Valley Section" (with a grade of 15 ft. per mile), should show some marked difference in the character of the material in California and New England, if the grades and moving agents were nearly identical.

With a rapidly increasing flow, water would find its way into the material of the river bed and banks or shores, and doubtless would

Mr. Dunham.

exert pressures tending to keep that material in place. The pressure would be reversed when a flood-plain was quickly lowered, but at any time only a slight down-stream movement of the river bed can be expected and that over only limited areas.

A profile of the Westfield River (Fig. 9), shows a section which may correspond to that of the débris cone. A few adjacent summit elevations with distances from the river channel, in miles or fractions of miles, are shown. Thus, "$\frac{1}{2}$ E" shows the elevation of the ground $\frac{1}{2}$ mile east of the river. The elevations are taken chiefly from U. S. Geological Survey quadrangles.

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IS IT ADVISABLE TO ESTABLISH A NATIONAL DEPARTMENT OF PUBLIC WORKS?

AN INFORMAL DISCUSSION AT A MEETING OF THE SOCIETY, SEPTEMBER 17TH, 1919.

BY MESSRS. GEORGE W. FULLER, WALTER D. BLAIR, C. T. CHENERY, A. B. FRY, ROGER D. BLACK, ALFRED D. FLINN, AND H. F. DUNHAM.

Mr. Fuller.

GEORGE W. FULLER,* M. AM. SOC. C. E.—This is the birthday of the Constitution of the United States. Its adoption after about four months of deliberation in 1787, was due to interesting causes. For about a decade the youthful nation had struggled on under the Articles of Confederation. These provided a sort of town-meeting plan, with Congress trying not only to legislate but to administrate. Although it had a Board of Treasury, a Board of War, and, at intervals, a Department of Foreign Affairs, business was conducted essentially by committees of Congress. When not in session, Congress expected to transact routine matters through a "Committee of the States", one for each State, with the execution of delegated power requiring the consent of nine of the States.

EARLY RECOGNITION OF NEED OF CONCENTRATING AUTHORITY.

The period just after the American Revolution was one of great discouragement and depression for the United States. Then, as now, it was recognized by careful thinkers that the successful administration of Government affairs requires reasonable concentration of authority and responsibility, as well as strict accountability to the people through their representatives. Ratification of the Constitution in 1789 served its purpose as to the establishment of Executive control and permitted the United States to go forward by leaps and bounds.

* New York City.

Mr. Fuller.

Public Opinion Must be Stimulated and Guided.

As knowledge increases and conditions change, there is no reason, under our form of government, why organization arrangements can not be fitted suitably for the work at hand. The single requisite is that citizens who know about these matters, should regard it as their solemn duty to take the necessary steps to crystallize the evidence adequately and to inform the people of the country as to the need of changes, the proposed programme to be adopted, and the benefits to accrue therefrom.

For more than a generation, engineers have striven for a National Department of Public Works. They did not push hard enough or far enough to crystallize public opinion in favor of their proposition, either in Congress or among the group of citizens especially interested in this line of work.

The great war now being brought to an official close required the United States vastly to increase its production along many channels. The direct and indirect needs of our own military establishment, as well as those of our Allies, have caused many of our citizens to study carefully the means of improving the management of affairs both private and public.

Requirements of Reconstruction.

Reconstruction in all its phases is and will be the problem of the hour in all countries. In the United States, we must not be content with the old-fashioned arrangements with their resulting loss of time and money. The past must take care of itself. For the future, we should take full advantage of our own rich, available experience to adopt at once better methods of doing public business.

The requirements of the public works in the United States keenly interest the engineer, the architect, and the constructor, who, with the taxpayers, desire to see efficiency and economy brought to as high a plane as practicable. This proposition is not limited to technical details by any means. On the contrary, it involves essentially the broad question of business management of public works, including construction, maintenance, and operation requirements, and needed investigations in connection therewith.

Chicago Conference.

In April, 1919, at the instance of Engineering Council, a conference or confederation of interested organizations took place at Chicago, Ill., with delegates from 74 technical societies with a membership of 105 000. The prime purpose of this conference was to consider the question of a Department of Public Works. It adopted important resolutions and appointed various committees to prosecute this movement to a logical and successful conclusion.

United States Behind the Times.

Mr. Fuller.

It has been found that, aside from military activities, engineering and allied work is conducted for the United States Government by more than thirty agencies, more or less loosely attached to some one of six Executive Departments, the head of which is a Cabinet Officer.

Practically every country in the world with a modern stable government has all these governmental activities concentrated in a single jurisdiction, except the United States.

In England, however, there are Commissioners of Works and Public Buildings who have control over land and buildings of all kinds belonging to the Government, while rivers and harbors and their appurtenances are under the jurisdiction of the Board of Trade.

M. O. Leighton, M. Am. Soc. C. E., Chairman of the Executive Committee, has prepared a summary of experiences abroad.

Magnitude of Public Works.

The construction enterprises of the Government are very extensive, as will be noted from past and current annual appropriations under review, which may be roughly summed up, as follows:

For buildings under the Supervising Architect	$20 000 000
River and harbor appropriations	40 000 000
Reclamation Service	6 000 000
Alaskan Railroad Commission	7 000 000
Bureau of Roads (in association with States)	200 000 000
Proposed land reclamation for soldiers	500 000 000

This list alone corresponds roughly to three-fourths of a billion dollars worth of work under consideration for the near future. This is exclusive of land, boundary, coast and geodetic, and hydrographic surveys, of which there are now twenty bureaus all working independently of each other. These enterprises do not include investigations of various kinds for the control of floods, drainage of swamps and flooded lands, geological surveys, Bureau of Standards, etc.

Department of Public Works in Place of Department of the Interior.

To remedy this situation, the Chicago conference has proposed to reorganize the Department of the Interior and establish in its place a Department of Public Works. This is the way the matter has been handled in a number of other countries.

In the United States, the Department of the Interior was created in 1849, following the Mexican War. It was originally called the Home Department, and took over the Patent Bureau from the State Department, Indian Affairs from the War Department, Pensions from the

Mr. Fuller.

War and Navy Departments, and the Census Bureau and General Land Office from the Treasury Department. It is conspicuous that, in the past, many bureaus have been shifted from time to time from one Department to another, some of them having had their attachment changed several times.

Proposed Changes in the Jones-Reavis Bill.

The bill for effecting these changes was introduced on June 25th, 1919, in the Senate by Senator Wesley L. Jones, of Washington, and in the House by Representative Frank C. Reavis, of Nebraska, and was referred to the Committee on Public Lands.

Such bureaus of the Interior Department as are non-engineering in character are to be placed under the jurisdiction of appropriate departments, while engineering bureaus from other departments are to be included in the Department of Public Works.

The bill proposes that the Patent Office be removed from the Interior Department and placed under the Department of Commerce. The Bureau of Pensions is assigned to the Treasury Department. The Bureau of Education goes to the Department of Labor. The Bureau of Indian Affairs also is transferred to the Department of Labor, with the proviso that the engineering and construction work and the land and mineral surveys, now performed under the direction of the Bureau of Indian Affairs, are to be prosecuted under the Department of Public Works.

St. Elizabeth's Hospital and the Freedman's Hospital, in Washington, D. C., are assigned to the Public Health Service under the Treasury Department. Columbia Institution for the Deaf and Howard University go to the Bureau of Education, under the provisions of the bill.

On the other hand, the Department of Public Works is to absorb the Supervising Architect's Office of the Treasury Department; the Construction Division, River and Harbor Improvements, Mississippi River Commission, and California Débris Commission of the War Department; the Bureau of Standards and the Coast and Geodetic Survey of the Department of Commerce; and the Bureau of Public Roads and the Forest Service of the Department of Agriculture.

The bill provides that the Secretary of Public Works "shall by training and experience be qualified to administer the affairs of the Department and to evaluate the technical principles and operations involved in the work thereof." The measure excepts from the foregoing provision the Cabinet Officer who is at the head of the Department at the time of the passage of the bill.

Four Assistant Secretaries, each to be paid $7 500 per annum, are provided. They shall be qualified by training and experience for their duties as specified. One is to have administrative jurisdiction over all matters of engineering design and construction. Another is to have

charge of architectural design and construction. A third is to have jurisdiction over all scientific work and surveys, while the fourth is to be in immediate charge of all land and legal matters. These Assistant Secretaries are charged with the duty of co-ordinating and bringing into efficient relationship all the activities of the Department so that it may be administered harmoniously and efficiently. They are included within the scope of any civil service retirement laws now or hereafter enacted by Congress, and are removable on charges duly made and adjudicated as provided by law. Mr. Fuller.

An important feature of the bill is the proviso that engineer officers of the United States Army, detailed on non-military work, are to be assigned by the Secretary of War to like duties under the new Department for not more than two years. This enables the Secretary of Public Works to make a gradual transfer of improvements and instrumentalities to the civil administration without detriment to public interest. Under the direction of the Secretary of Public Works, members of the Corps of Engineers may be detailed by the Secretary of War to temporary duty in the new Department for such instruction, training, and experience as is desired.

Present Conditions to be Remedied.

1.—Diversity of Effort.—Six departments and thirty bureaus, each department with its cabinet member head, their respective assistant secretaries and staffs, together with thirty bureau chiefs, their assistants and staffs, have a hand in some part of the public works of the United States. Each department that functions on public works projects has something else to do. The public works features are only a part of their activities and, in some cases, only a small part. No high executive authority in the Government is able to confine his efforts to public works alone. The result is a waste of effort, high overhead costs, divided accountability, and lack of sustained policy.

2.—Divided Responsibility.—Effort by many parties, directed to one objective, *via* different routes, as heretofore described, is demoralizing. The work suffers because "too many cooks spoil the broth."

3.—Competition of Bureaus.—Too many bureaus are doing the same kind of work, with overlapping jurisdiction in some measure. Actual performance is associated too much with the caprice of appropriations, with consequent disorganizing effect on those bureaus which are unsuccessful in their attempt to get jurisdiction. Various bureaus seem to be subject, more or less, to lapses and irregularity in performance, due to lapses and caprices of appropriations.

4.—Inadequate Direction and Co-ordination.—Lack of concentration, both as to authority and responsibility, makes for inadequacy of direction of performance and shortcomings as to needed co-ordination of work. There is also a consequent lack of continuity of policy in

Mr. Fuller. the establishment and management of public works conducted for the benefit of the people.

The foregoing deductions are based on available data which Chairman Leighton is arranging to publish in the form with which modern business is familiar, showing organization charts, financial statements, lists of personnel, overhead charges, and other practical features of past performances.

Benefits to be Secured.

1.—Efficiency.—A trained administrator, under suitable conditions as to concentration of authority and responsibility, could unquestionably effect substantial improvements making for efficiency along lines, as follows:

(a).—Adequate direction.

(b).—Handling appropriations more advantageously than at present; this will become increasingly true on the adoption of the budget system.

(c).—Establishment of a co-ordinated continuance of policy along various lines of public works, with bureaus directed to co-operate, instead of being permitted to compete on and for important measures, as at present.

(d).—Establishment of an *esprit de corps* that would make for a higher grade of performance.

2.—Economy.—Resulting from the foregoing benefits and efficiency should be corresponding economies which would either allow more work to be done with the same amount of money raised by the people through taxation, or which would allow the same amount of work to be done with less demands through taxation. Probably a mixture of both benefits will result.

3.—War Preparedness.—This phase of our National life will be benefited by this movement through the opportunity afforded for giving individual members of the Engineer Corps more varied practical experience than hitherto in the management of affairs, and also by maintaining a Federal civilian engineering organization in readiness to furnish a substantial number of well trained constructors, familiar with Government methods, for performing Government work of civilian character in times of war. It is true that these are secondary matters, but the speaker attaches great importance to them.

Relations to be Avoided.

1.—Construction Division, United States Army.—In the minds of some, it appears that this movement is in support of the Construction Division of the Army or some personnel attached therewith. This is not the speaker's understanding. On the contrary, he believes that this proposed movement should be maintained on an absolutely impersonal

basis. As far as the Construction Division is concerned, it is its methods, and not its personnel, already demobilized to a large extent, that is of importance as regards the public works of the Government. The methods of the Construction Division, in the speaker's judgment, are founded on sound modern principles, concerning the management of large work, as follows: Mr. Fuller.

(a).—No man in immediate charge of work is given responsibility beyond that which may be reasonably expected, as regards the range of types of tasks which one man can look after adequately, with the aid of proper assistants; and the same is true as to magnitude of work.

(b).—The organization is such that a man in final authority in charge of policy, finance, labor, materials, and other controlling items, can be reached without delay by the man in charge of any project.

Experience shows that these are important features in eliminating red tape whereby officials of intermediate authority bring about nonperformance, either by pigeon-holing requests for directions or by "passing the buck" to some one else equally unable or unwilling to function on the matter.

2.—Engineer Corps, United States Army.—As to the Engineer Corps of the Army, there is no reason why serious friction should arise from its members, or with them, if the proposed movement is carried out in a rational way. Nothing should be done to injure their military status when they are taking advantage of opportunities for acquiring a more intimate knowledge of conducting engineering work and of managing men than is possible along strictly military lines. Civilians interested in this movement should give attention to means of bettering the standing of military engineers in their chosen field and of co-operating with them, in a businesslike way, in respect to civil engineering matters and to relations between military and civil engineers.

Future Programme for Army and Civilian Engineers.

Prior to the war, civilian engineers on Government work were unhappily circumstanced for the welfare of the work in hand and of themselves, compared with the Army engineers. During the war, available evidence indicates that the performances of the Army engineers were affected by lack of broad practical experience in conducting operations on a sizable scale. It is also a fact that civilian engineers on war work had their usefulness lessened by unfamiliarity with Army regulations and the requirements of the military establishment.

The speaker is one of those who believes that, for the good of the country, a thorough-going study should be made at once of how best

Mr. Fuller.

to bring on to a modern efficient basis all the engineering activities of the Federal Government for both war and peace conditions.

Some persons seem to feel that the Jones-Reavis Bill starts out with a fearful handicap, because it does not meet the favor of some of the older Army engineers. The speaker does not share that view. This bill will stand or fall depending on the ability of its proponents to show, beyond reasonable doubt, the real benefits to accrue from it from the standpoint of the business man. With this accomplished, it is largely a question of publicity in formulating public opinion adequately throughout the country.

The speaker has no idea that the Ransdell Bill, to put all public works of the Federal Government under the charge of the Chief of the Engineer Corps of the Army, will be passed by Congress.

Army engineers should have their status improved. It is doubtful whether they can do this without the aid of civilian engineers who know about Federal engineering requirements during both war and peace, and who are willing to co-operate in a fair-minded way in formulating an efficient future programme.

Labor organizations, business men, farmers, and other groups of men co-operate efficiently. Why not engineers? The speaker urges that they do so.

Effect on Other Activities.

The question has been asked as to how the other bureaus and departments would be left after the establishment of the Department of Public Works. It is the speaker's understanding that they will not be less advantageously placed than at present.

Inquiry has also been made as to the scope of Federal public works in relation to activities of States, sub-divisions thereof, and private enterprises. So far as is known the status of the latter will in no case be involved.

It is realized that many inquiries will be made, and it is the purpose of the Executive Committee to answer them all as rapidly as data can be procured. Criticism of the Jones-Reavis Bill is invited to, and in preparation for, the Committee hearings in Congress next winter.

Other Federal activities are under review, from the standpoint of modernizing the methods of procedures. Engineers will have to be alert to keep abreast of the times.

Requirements as to Funds.

It has been estimated by the Central Finance Committee that at least $100 000 will be required during the coming year to conduct this campaign efficiently. This is none too much to pay for the necessary traveling expenses and the assistants who must be employed to make the necessary searches to prepare and distribute adequately the material

needed by the various local committees at work in support of this movement. Mr. Fuller.

This means, on an average, $1 from each person having membership in the technical organizations participating in the Chicago conference. Presumably, some of the members will not contribute through inability or indifference. It is suggested that each member of the national technical organizations contribute at least $2, and that if a member has an annual income of $10 000, a contribution of $25 should willingly be forthcoming to advance this movement.

Funds must be forthcoming; otherwise, the movement will fail. From the Eastern District of New York not less than $10 000 should be raised by the members of this Society and other organizations. It is expected that, in the early future, a programme will be evolved for co-ordinating equitably the raising of funds, as between the organizations and districts of the United States.

WALTER D. BLAIR,* ESQ.—The desirability of a Department of Public Works is as self-evident as the multiplication table. The speaker will not praise the idea, but he would like to praise the public service and the foresight shown in the work which the National Service Committee of Engineering Council, in Washington, has accomplished in formulating plans for a Department of Public Works. Engineers who are not conversant with the business of that Committee have no idea of the immense work which it has undertaken, the immense amount of research that it has followed, in order to get the necessary data to lay a broad foundation for its plans. Mr. Blair.

The speaker is going to assume that a Department of Public Works has been established. What benefits would the Architectural Profession obtain from such a Department? The first great benefit would be that, with such a Department, it would be possible to establish a National building policy. At the present time, the Supervising Architect has no control whatever over the type of building that is to be erected in any place. He is simply told to spend so much money. No agency has been established for relating the type and size of the building to the needs of the Government. For instance, in reviewing the appropriations for post-offices, it will be found that the size of the building bears no relation whatever to the postal business. It will be found that the size of the appropriation is dependent entirely on the influence of the Congressman of that particular district, and whether he happens to have served on the Postal Committee, and how long. If one goes back through the past two or three years, during which time the head of the Postal Committee was from Florida, and looks through the appropriations for post-offices, it will be found that almost every little village in his

* New York City.

Mr. Blair

district possesses a large building. Buildings that have cost $50 000 and $75 000 have been built in places where the gross postal receipts are less than $2 000. It will also be found that some of the buildings in Tennessee have cost $50 000, in places where the annual postal receipts have been less than $1 200. That is, of course, the grossest kind of inefficiency, and it is possible that if a Department of Public Works was established, the buildings erected for the Government's needs would bear some relation to the business conducted in them.

If such a Department was established, there would also be a closer relation between the engineering and the building activities of the Government, so that architecture and engineering would be considered at the same time; that one would not be attempted without, or be superimposed on, the other; that the creative instincts of both the engineers and the architects would be developed simultaneously in the building projects of the Government. The result would be increased efficiency and increased beauty; because it must not be forgotten that "beauty is a thing of joy forever" and that it has a great economic value. As a signal example of that fact, one has only to think of Paris, where a certain sum of money has been spent to produce beautiful results. There are sections of other cities on which, perhaps, greater sums of money have been spent, without any consideration of creative beauty, with a correspondingly decreased economic value. The engineer as well as the architect is perfectly willing to recognize the economic value of beauty, provided he has the opportunity. The fault of the architect in the past has been that he has spent too much money. The fault of the engineer, if one can generalize with the exaggeration that goes with all generalization, has been that he has spent too little money. He has been too economic; whereas, the architect has erred on the other side.

If a Department of Public Works is established, it is reasonable to expect that there will result a certain standardization of buildings and methods of building, certain standardizations of engineering—which is less needed in the Engineering Profession than in the Architectural Profession—from which there will be a corresponding benefit to the public. There will also accrue a great mass of data in regard to public works, which will be of intense interest and value to the public as well as to the Profession.

Attention is called to the fact that the proposed Department of Public Works necessarily will be dominated by the Engineering Profession. The Architectural Profession will be in a subordinate capacity, due to the fact that the bulk of the work to be done will be of an engineering nature. The establishment of a Department of Public Works is, therefore, primarily the engineer's fight. The engineering work will bulk so large that it will affect the Engineering Profession directly. It concerns engineers to formulate the plans to

bring it into effect, and they can easily demonstrate to the American people that if there was such a Department, they would have in that Department the foresight to lay out the future development of the country. For that is what it comes to. How can we develop the economic resources of the country so as to produce the greatest wealth for the greatest number? That is the problem that is going to concern the engineer, and it is going to require great vision and all the learning that the Profession possesses. The speaker thinks that engineers can handle the problem, that they can convince the American people that they are worthy to handle it, and he is sure that they can count on the co-operation of the architects in bringing about this result. Mr. Blair.

C. T. CHENERY,* ESQ.—*Historic.*—In 1884, the members of the Engineering Profession were so impressed with the ineffective organization of the Federal Departments and the growing importance of National Public Works, that they inaugurated a campaign to create a National Department of Public Works, in which the public works functions of the Federal Government would be consolidated. At that time, engineers were a more detached group and less interested in public affairs than they are to-day. They were unable to put behind this movement sufficient drive and push to carry it through, and the matter lapsed. Since that time, however, the public works functions of the Government have continuously increased. The Forest Service has been added, as well as the Alaskan Engineering Commission, the Reclamation Service, the Bureau of Roads, the Bureau of Standards, National Park Service, and the Bureau of Mines, so that since the initial attempt to establish such a Department was made, the public works functions of the Federal Government have increased many fold. They have increased, however, by an unguided growth until now they are scattered through six of the Executive Departments. Thoughtful engineers have watched this continuous growth of the public works functions and their scattering through many bureaus with that pained interest with which good executives view the ineffective operation of large enterprises, which enterprises, through proper administrative organization, might become models of efficiency and business administration. Mr. Chenery.

In February, 1919, Engineering Council sent out invitations to societies of engineers, architects, geologists, chemists, and constructors to attend a conference at Chicago, Ill., to consider the question of National public works. This Conference was held April 23d–25th, 1919, and was attended by delegates from 74 societies, with a combined membership of approximately 105 000 engineers and allied professional men. At this Conference were highly qualified men, whose interests extend

* Secretary, Engineers', Architects', and Constructors' Conference on National Public Works, Washington, D. C.

Mr. Chenery.

beyond the realm of their own professions and into that of National affairs.

It was the judgment of this assemblage that a National Department of Public Works should be created, which should embrace the more important engineering functions of the Government. Each of the various engineering bureaus of the Government was considered and balloted on by the Conference to decide whether, in the opinion of the delegates, such bureaus should be included in the proposed Department. Decisions were made, and out of this Chicago Conference was created a permanent Conference on National Public Works, with headquarters in Washington, D. C. The Text of Bill Committee of this Conference drew up a bill embodying the views of the delegates, and this bill, introduced by Senator Jones, of Washington, and Representative Reavis, of Nebraska, on June 25th, 1919, is known as the Jones-Reavis Bill (S. 2232; H. R. 6649).

Reasons for the Establishment of Such a Department.—The executive machinery of the Federal Government consists of departments, the heads of which are Cabinet members, and of certain related boards and commissions, the greater part of the work being allocated to the several departments. These departments are found to be largely the result of unguided growth. In their creation, there has been little plan or design, and several of them are little more than groups of rather unrelated bureaus.

An examination, for instance, of the Treasury Department shows that several diverse, unrelated, and important functions are exercised by its Secretary. The primary business of the Treasury Department is to administer the finances of the Nation, but the Secretary of the Treasury has also supervision over the Supervising Architect's Office. He is responsible, therefore, for the design and construction of post offices, custom houses, marine hospitals, and other classes of Federal buildings wherever they may be found from Boston to Los Angeles and from Jacksonville to Seattle. This construction involves an average annual expenditure of about $20 000 000.

Besides being a financier and an architect, the Secretary of the Treasury is also an insurance man, in that he has supervision over the Bureau of War Risk Insurance which, at one time, had in effect 4 000 000 policies with $36 000 000 000 worth of insurance in force. This Bureau employs about 15 000 persons.

The next function of the Secretary of the Treasury is to supervise the Public Health Service. Through this service, he collects vital statistics, tests water supplies, administers the quarantine laws, advises in such epidemics as influenza, and generally supervises the Nation's health. The Secretary, therefore, has added to his functions of financier, architect, and builder, that of a doctor; but he is not through yet. He also administers the Coast Guard, the functions of which are

Mr. Chenery.

the enforcement of maritime regulations, the removal of obstructions to navigation, the detection of smugglers, and it also serves as an auxiliary naval arm in the event of hostilities. He, therefore, adds to his functions those of a mariner, an engineer, and a policeman. He has still more work to do, for he is also responsible for the Bureau of Printing and Engraving. This Bureau designs, prints, and engraves all monies, securities, notes, and bonds of the Federal Treasury, including stamps, licenses, passports, commissions, patents and pension certificates, and portraits of deceased members of Congress and of other public officials. The Secretary, therefore, is primarily a banker, but he is also an architect, a builder, a doctor, a propagandist, an insurance agent, a mariner, a life-saver, a policeman, a printer, and a portrait painter.

It is the present business belief that departments should be built up of closely related activities which require for their adminstration the same type of education, training, and administrative ability. In considering the Treasury Department, it is realized that a man may be a first-class financier and know nothing of public health, or that he may be an able insurance man and know nothing of navigation, and that if, through any freak, he were to be familiar with all four of these services, the chances are a hundred to one against his being competent to administer a department of architecture and construction. If such a grouping of unrelated functions in one department were confined to the Treasury Department, the condition would not be so serious. When one considers the Interior Department, however, it is found that this condition is greatly intensified.

The Secretary of the Interior must operate the Reclamation Service and Freedman's Hospital, the Geological Survey and the St. Elizabeth's Insane Asylum, the Bureau of Mines and Howard University, the Alaskan Engineering Commission and the Bureau of Education; must breed reindeer in Alaska and pass on pension claims in Washington; must rule on the patentablity of inventions, the priority of trademarks, and, at the same time, act as guardian of about 300 000 Indians; and he must administer the public lands, direct the National Parks, and administer the Columbia Institution for the Deaf.

The same illogical grouping of bureaus and functions is found in the Department of Agriculture and the Department of Commerce, though to a less grave extent.

In the actual administration of a department, the Secretary must necessarily find it impossible to supervise in person these divergent and unrelated activities. He must delegate administrative jurisdiction over the various bureaus, either to the bureau chiefs or to assistant secretaries. To refer to the previous example of the Treasury Department, it will be found that there are five assistant secretaries. One has charge of customs; a second of public buildings and miscellaneous

Mr. Chenery.

bureaus; a third of fiscal affairs; a fourth of Internal Revenue and War Risk Insurance; and the fifth of the Farm Loan Bureau. Of the five assistant secretaries, four, therefore, are assigned to the administration of financial affairs. The item "miscellaneous bureaus" covers the Public Health Service, the Bureau of Printing and Engraving, the Coast Guard, the Supervising Architect, the General Supply Committee, the Chief Clerk of Appointment Division, the Mails and Files Division, the Printing and Stationery Division, and the Security Bond Division. The Coast Guard, the Public Health Service, the Supervising Architect's Office, and the Bureau of Printing and Engraving are important major activities. Each of these bureaus employs hundreds of men and spends yearly millions of dollars, but, for their administrative jurisdiction and control, they are entitled to only one-tenth of the time and consideration of an assistant secretary who receives $5 000 a year. All these bureaus, therefore, must suffer from their necessarily subordinate positions. They cannot receive the full consideration and interest and the intelligent direction which is necessary to their development for highest usefulness.

It is hard to find a parallel for this situation in the business world. If department heads are considered as presidents of corporations, then the assistant secretaries would be vice-presidents, and the bureau chiefs would be department heads. This comparison will not hold, for corporation departments are divided into specialized functions, such as raw material, production, manufacturing, transportation, purchasing, sales, collections, credits, and auditing, each in charge of a highly specialized executive who knows his department and his duties both in basic principles and in detail.

Obviously, then, the Federal bureaus cannot be compared to the executive departments of a corporation. To approximate their position, the Federal Departments must be considered as holding corporations and the bureaus as subsidiary companies. Here, again, the analogy meets difficulties. When holding companies are organized in the business world, they are generally formed of companies engaged in similar business or activities. The Steel Corporation is a holding company, but all its subsidiary companies are engaged in the manufacture of steel. All the subsidiary companies of the Standard Oil Company are engaged in the production of oil. All the subsidiary companies of the American Telephone and Telegraph Company are engaged in the telephone business, except the Western Electric Company which is engaged in the manufacture of telephone instruments. If a business group had large numbers of functions to perform such as mining, lumbering, real estate development, railroad building, and steamship operating, they would not organize five holding companies, each superior to operating organizations engaged in each of these varied activities. The Federal Government has, therefore, ten holding corporations which,

Mr. Chenery.

under a National scheme of organization, would be made up of companies engaged in similar business. As at present organized, the departments are made up of such diversified activities as to make their effective operation almost an impossibility. Such an organization, if transferred into the business world, would shortly involve in bankruptcy any corporation trying to operate under it.

Such a grouping of bureaus and functions as one finds in the Federal Government cannot be justified on a business basis. Not only is their grouping illogical, but many of these departments are doing similar work. One finds, for instance, that the Corps of Engineers in the War Department, the Coast and Geodetic Survey of the Commerce Department, and the Hydrographic Survey of the Navy, are all making surveys of harbors.

There are about eighteen bureaus making surveys or maps, and these maps often show the result of a lack of co-ordination, namely:

War Department.—Corps of Engineers; Mississippi River Commission; California Débris Commission; Alaskan Road Commission; Panama Canal.
State Department.—International Boundary Commission.
Navy Department.—Hydrographic Office.
Post Office Department.—Rural Routes.
Department of Commerce.—Coast and Geodetic Survey.
Department of the Interior.—General Land Office; Indian Affairs; Geological Survey; Reclamation Service; Alaskan Railway Commission; National Park Service.
Department of Agriculture.—Bureau of Public Roads; Forest Service; Bureau of Soils.
Interstate Commerce Commission.

The following bureaus engage or may engage in construction work of one kind or another:

Treasury Department.—Coast Guard; Supervising Architect; Public Health Service.
War Department.—Construction Division of the Army or Quartermaster; River and Harbor, Corps of Engineers; Mississippi River Commission; Alaskan Road Commission; Panama Canal; Ordnance Department; Chemical Warfare Service; Tank Service; Aviation Service; Motor Transport Service.
Department of Justice.—Superintendent of Prisons.
Post Office Department.—First Assistant Postmaster General.
Department of Commerce.—Coast and Geodetic Survey; Bureau of Standards; Bureau of Lighthouses; Bureau of Fisheries.
Navy Department.—Bureau of Yards and Docks; Bureau of Construction and Repair; Bureau of Steam Engineering.

Mr. Chenery.

Department of the Interior.—Indian Affairs; Geological Survey; Reclamation Service; Bureau of Mines; Alaskan Railway Commission; National Park Service.

Department of Agriculture.—Forest Service; Bureau of Public Roads; Bureau of Animal Industry; Bureau of Plant Industry; Weather Bureau.

The following Government agencies operate, or may operate, fleets:

Treasury Department.—Coast Guard.

War Department.—Transport Service; Corps of Engineers; Mississippi River Commission; Panama Canal.

Department of Commerce.—Coast and Geodetic Survey; Bureau of Lighthouses; Bureau of Fisheries.

Navy Department.—Bureau of Navigation.

Department of the Interior.—Alaskan Railway Commission.

Emergency Fleet Corporation.

The following Government agencies make, or may make, chemical tests or researches:

Treasury Department.—Internal Revenue; Mint; Bureau of Engraving and Printing; Public Health Service.

War Department.—Surgeon General of the Army; Chemical Warfare Service; Ordnance Department; Panama Canal.

Navy Department.—Surgeon General; Ordnance Department; Bureaus of Yards and Docks; Bureau of Steam Engineering.

Department of the Interior.—Geological Survey; Bureau of Mines.

Department of Agriculture.—Bureau of Animal Industry; Bureau of Plant Industry; Forest Service; Bureau of Chemistry; Bureau of Soils.

Department of Commerce.—Bureau of Fisheries; Bureau of Standards.

United States Shipping Board.

These agencies are listed to show how widely spread are the same functions in Federal Bureaus. Not all the bureaus listed as doing construction work are now so engaged, but all may so engage. When these intermittent ones do build, however, it is with an emergency organization. It would be absurd to advocate consolidating all these bureaus into a construction department, because they may engage in such work. They illustrate, however, the necessity for a co-ordination of such work in a department which would be made up of bureaus the chief interests of which are along such lines and which might act as contractor or agent for other Government departments in their construction matters.

Mr. Chenery.

The lack of a permanent personnel skilled in public works operations is another of the serious conditions which is due to present administrative methods. At this time, when it is necessary to undertake any large engineering or constructional enterprise, it is usually necessary to get together an emergency organization for the purpose. This organization is held together as long as the work is in progress, and then is scattered to the four winds. Engineers come into the Government service, serve a short time, and go back to private work. The knowledge and experience which they have gained of Government methods and requirements is totally lost to the Government. In competition between permanent and emergency organizations, the permanent ones always have a large handicap in their favor. This was exemplified in the late war by the superior ability of the du Pont organization to construct powder manufacturing plants, covering whole cities and practically every phase of manufacturing activity, in much less time and with much less expense than their nearest competitors, who were not experienced in this particular type of work and did not have a permanent organization, though the administrative ability of the competitor was equal to that of the du Ponts.

The questions of a permanent organization and of the lack of a budget are inevitably tied together. At present, we not only use emergency organizations, but emergency plans. In Federal public works, in many cases, there is no comprehensive plan laid down for projects covering a number of years in advance and indicating the general expenditures which will be made over this period. This condition is so accentuated in the River and Harbor Improvement that the Chief of Engineers has stated that he finds it entirely impracticable to have an organization chart of his Department, as his organization varies widely from year to year, in accordance with Federal appropriations. Budget legislation is being pressed at the present session of Congress, and is meeting with a rather belated approval. It fits in well with the public works movement.

Tables 1 and 2 give an idea of the extent of the activities of the Bureaus affected.

Method of Creating a Public Works Department.—The next consideration after the decision was made by the Chicago Conference to approve the project for a National Department of Public Works, was to determine the best method for the creation of such a Department. There are now a sufficient number of Departments in existence to handle satisfactorily the Nation's business, if the various bureaus comprising them were regrouped. The Interior Department contains the majority of engineering bureaus and services and employs more engineers than any other Government Department. It was decided, therefore, to recommend that the name "Department of the Interior" be changed to "Department of Public Works." From the Department

Mr. Chenery.

TABLE 1.

Bureau to be in National Department of Public Works.	From Department.	Total Number of Employees: Washington.	Total Number of Employees: Field.	Total Appropriation.
General Land Office	Interior	514	750	$ 705 390
Geological Survey	"	718	253	1 538 137
Reclamation Service	"	89	3 774	9 445 000
Bureau of Mines	"	252	655	3 145 377
National Park Service	"	11	177	1 039 705
Alaskan Engineering Commission	"	4	2 150	5 250 000
Supervising Architect Office	Treasury	214	19	221 000
Construction Division, U. S. A.	*War (Q. M. Corps)	1916 approx.	1 800	4 431 712
River and Harbor Improvements	War	50–100	16 000	28 369 159
Mississippi River Commission	†War (Engr. Corps)	Average	Civ. average	3 315 209
California Débris Commission	War (1916)	Pre-war	Pre-War	15 000
Coast and Geodetic Survey	Commerce	213	190	1 337 359
Bureau of Standards	"	1 051	124	1 749 100

* The appropriations and personnel strength of the Construction Division and Engineer Corps were taken in 1916 to obtain pre-war conditions. The figures of the personnel strength are approximate. The total appropriation for the Construction Division as given is the sum of the appropriations for all non-military construction works.

† Personnel averages are given for the three departments named: exact figures for 1915, 1917, and 1918, are, respectively, as follows: 24 862, 17 640, and 18 953. The 1916 personnel strength was not obtainable. There is an average of slightly more than 20 000, which, when divided in the proportion of money expended, gives approximately 16 000 employees on the three items named.

TABLE 2.

Bureau to be Transferred from Interior Department.	To Department.	Total Number of Employees: Washington.	Total Number of Employees: Field.	Total Appropriation.
Patent Office	Commerce	959	0	$1 565 000
Bureau of Pensions	Treasury	962	0	1 418 620
Bureau of Education	Labor	169	320	159 760
Bureau of Indian Affairs	Labor	264	5 826	11 021 910
St. Elizabeth Hospital	Treasury	850	0	426 750
Board of Indian Commission	"	.....	.....	.....
Freedman's Hospital	Treasury	115	0	84 808
Columbia Institute	Labor	70	0	94 000
Howard University	"	80	0	117 938

of the Interior, as at present constituted, it was planned to transfer the bureaus which were of a non-public works nature, such as the Bureau of Pensions, the Patent Office, St. Elizabeth's Hospital, Freedman's Hospital, Howard University, and the Indian Office, except for the construction work. This left in the Interior Department as a nucleus for the Department of Public Works the Reclamation Service,

Mr. Chenery.

Alaskan Engineering Commission, Bureau of Mines, Geological Survey, National Park Service, Land Office, and the constructional activities of the Commission of Indian Affairs. To round out the Public Works Department, it is planned to transfer to it the Forest Service and the Bureau of Roads from the Agricultural Department, the Bureau of Standards and the Coast and Geodetic Survey from the Department of Commerce, the Supervising Architect's Office from the Treasury Department, and the River and Harbor Improvement, California Débris Commission, and Mississippi River Commission from the War Department. This will give a well-rounded Department the primary interests of which are all engineering, construction, surveying, or engineering management.

Administration of the Department.—To administer this Department the Jones-Reavis Bill provides for the selection by the President of a Secretary who is by training and experience qualified to administer such a department. He is to be assisted by four assistant secretaries who are to be appointed by the President and are to hold office during life or good behavior. It is further proposed that one assistant secretary is to be in charge of construction, one in charge of surveys and research, one in charge of architectural design and construction, and the fourth in charge of land and legal matters. Each of these assistant secretaries is to be paid a salary of $7 500 per year, and they are to serve continuously and to receive the benefit of any retirement laws now enacted or which may hereinafter be enacted by Congress. These men are all to be especially qualified by training and experience to hold the positions for which they have been selected.

There has been much criticism of the compensation to be paid to these assistant secretaries, it being believed by many engineers that competent men cannot be secured at the salary named. It is the view of the Conference, however, that the permanency of employment, together with the opportunity to participate in large activities, coupled with the provision for retirement pay, will serve to attract men of the desired caliber.

Why Certain Bureaus are Included in This Department.—The Alaskan Engineering Commission, the Supervising Architect's Office, the Bureau of Roads, the Coast and Geodetic Survey, the Geological Survey, and the Bureau of Mines require no justification for their inclusion. They are so evidently engineering and constructional activities that they would necessarily be included in any suggested plan of public works. When one comes to the Land Office, the Forest Service, and the National Park Service, the situation is briefly this: These three bureaus, together with the Reclamation Service, the Geological Survey, and the Bureau of Mines, are tied up so closely in the administration of Public Lands that the grouping of these seven bureaus under one roof would aid in simplifying the administra-

Mr. Chenery.

tion problems of them all. Land classification and administration, the construction of roads and trails, the providing of protection to public property, are common to all. They are so closely allied that many of their functions overlap, and their points of contact are so many that consolidations should be made and common policies enunciated applying to the entire group.

The Forest Service is devoting the majority of its efforts to the preservation of the present standing supply of timber. Of its $4 000 000 annual expenditure, $2 400 000 were available for the construction of roads and trails at the beginning of the last fiscal year, and an additional average of $500 000 per year is spent in fire protection. The primary purpose of the construction of roads and trails in the National Forests is to make these forests accessible and for actual fire fighting. The making of timber available to the market is a secondary consideration. Reforestation is occupying only a small portion of the Service's time, and less than 7 000 acres were replanted and reforested in 1918. The real business of the Forest Service, then, is to administer the property which it now controls and to preserve and to conserve it by the prevention of forest fires and of trespass. This is an engineering management task, and so far overshadows the silvicultural work of this Service as to justify the conclusion that the engineering features are at present the dominant ones.

The Bureau of Standards is designed to serve as consulting engineer to the Public Works Department, and, through it, specifications and performances will be standardized.

The engineering and constructural work of the Indian Service is included under the Public Works Department, but this merely provides for an arrangement similar to the one now in effect. At present, the irrigation work of this Service is being done by the Reclamation Service.

The primary purpose of the Indian Service is to socialize the Indians and fit them for self-government. As the Labor Department is the department of social welfare, it has been thought proper to suggest the transfer of the Indian Service to this Department, with the exception of the services just discussed.

Certain of the civil functions of the Corps of Engineers are scheduled for transfer to the Department of Public Works. These functions are River and Harbor Improvement, the Mississippi River Commission, and the California Débris Commission. On account of this provision, this measure has aroused rather naturally the hostility of the Corps of Engineers, the members of which have come to feel that they have almost a vested interest in this work from their long association with it. The present relations between civil and military engineers require a rather careful and tactful handling, if each of these groups is to render to the other the service of which it is capable. There is at

present a very apparent feeling of irritation on both sides, which is due rather to a great number of pin pricks than to any one specific thing. There is nothing in particular to be gained by not looking this situation squarely in the face and seeing just what these causes are. This is the old quarrel for precedence and prestige. During the war, the temporary engineer officers felt that the engineering operations were being conducted always with the end in view of securing greater prestige for the Regular Army engineers. They also felt that the members of the Corps had a feeling of superiority, which neither their training, abilities, nor experience justified; that although promotion was supposed to be selective, it was not so in fact, and that men who, at the beginning of hostilities, were Lieutenants in the Corps of Engineers of the Regular Army, could foretell almost to the month when they would receive their Lieutenant-Colonelcies. That is one side of the picture. Mr. Chenery.

The other side is that men who had served 7, 8, 9, or 10 years before getting their Captaincies, saw men come in from civil life commissioned as Majors, who knew nothing of military matters and nothing of discipline. They saw the high standards of the Corps of Engineers broken down, and sergeants of the old Regular Army who could hardly read and write get commissions in the Engineers. They saw men who had been graduated from training camps as Lieutenants obtain their Majorities in months. There was, therefore, good reason for them not to desire to consider emergency officers on the same basis as the carefully selected men who had made up the Corps. Most of these new officers did not hold themselves well, wore their caps on the backs of their heads, gave commands without a rising inflection, got all tangled up with their horses on parade, and generally did not give the appearance of being smart soldiers. It was inevitable that friction should arise. The viewpoints of the two groups were too dissimilar for them to merge, and, now, certain members of the Corps have a distinct feeling that a cold-blooded attempt is being made to rob them of their cherished functions.

It is quite true that the Jones-Reavis Bill does take away river and harbor work from the Corps of Engineers, but it substitutes in its place a provision that members of the Corps may be detailed to work in the Department of Public Works and there secure such training and experience as will be needful to fit them for their duties in time of war.

The first duties of the Corps of Engineers in time of war will be on the lines of communication. This work will involve road construction, bridging, light railways, and the construction of earth works. Service under the Department of Public Works will provide experience in practically all these classes, with the exception of light railways,

Mr. Chenery.

and would much better fit the needs of the members of the Corps than their present assignment of river and harbor improvements.

It is interesting to note that former Col. Roger Black, Corps of Engineers, U. S. A., M. Am. Soc. C. E., made the statement that the General Staff now felt that the Corps of Engineers would be benefited by relieving it of duties in connection with the river and harbor improvements, thus permitting its members to devote their entire time to military duties. Although the speaker does not feel competent to pass on this point, yet it seems to be quite clear that in times of peace members of the Corps of Engineers should be given a widely diversified engineering training, and especially so along the lines in which they will be called to engage in time of war. In the Public Works Department, as at present sketched, there will be an opportunity for each class of engineering experience, and it is hoped that, on careful consideration of this matter, the Corps of Engineers will feel that its best interest may be served by co-operating with civilian engineers in the formation of such a Department, and by taking an active part in its administration. Engineers very cordially invite its members to such co-operation and assure them that they realize fully the great services which they have rendered and may render again, and have no thought of attempting anything to lessen their value or decrease their prestige.

Benefits to Be Derived.—If the Jones-Reavis Bill is enacted, and the Departments enumerated are grouped together, it seems fair to assume that many of the present abuses incident to Government executive methods will be eliminated:

Specifications and tests will be standardized.

Surveys will be co-ordinated.

Overlapping will be abolished.

There will be men in charge of the various functions who are competent to make intelligent decisions concerning them.

Duplications will be eliminated.

A permanent and skilled personnel will be created for the administration of public works.

The advantages of doing work with a permanent rather than with an emergency organization will be realized.

A permanent body of skilled, experienced men of a caliber not now available, except in a few cases, would be created whose permanence of employment and pride of accomplishment would create an excellent *esprit de corps.*

It would permit of unified control of public works and a comprehensive plan for their continuance according to modern and businesslike financial plans based on an annual budget.

It would give great stimulus to technical research and study, and create machinery whereby we could compete more nearly on

a parity in mechanical matters with the research departments of other great powers, and, finally, Mr. Chenery

It would provide the nucleus of a trained organization which would be capable of quick expansion to meet the constructional needs of the country in the event of war.

To sum up, the present grouping of Government Bureaus in departments is economically unsound and cannot be justified by business tests. The proposed creation of a Department of Public Works would group together similar departments under one administrative head, thereby providing a functional organization which is the accepted business method for carrying on executive work. The creation of this Department is a step in the right direction and will fit in with any sound general re-organization plan which may be advocated for Government Departments, as it is based on sound economic premises. This Department will be capable of having a vast influence on the industrial life of the Nation. In fact, such a Department might be made to serve as the Nation's industrial governor by speeding up its activities in time of depression and by cutting them down in times of prosperity, and in this way perform a service which is sorely needed and, at present, entirely unavailable.

The introduction of this measure opens the way for engineers to step into their rightful place as leaders of opinion and as moulders of policy. The reformation which it proposes, is fundamental—it goes to the very basis of our executive machinery.

The engineering work of the Government can be put on an efficient basis if engineers will overcome their accustomed inertia in all matters not directly pertaining to their own profession, and get solidly behind this measure.

In every State engineers are now spreading the gospel that engineering efficiency should be applied to Federal engineering projects, and that civil engineers should not only have the work of executing these projects, but should also share in the resulting prestige, in such proportion as they have contributed to the success of the undertaking. To carry on this work is now the privilege of every engineer.

A. B. Fry,* M. Am. Soc. C. E.—The speaker approaches the discussion of this subject with great diffidence, as he is one of the unfortunate creatures who for nearly 35 years have been alternately mariners, builders, and even a species of brevet medicos as engineers in charge of marine hospital buildings, as a part of their routine duties. He finds, however, that he cannot agree with the conclusion that "whatever is, is right." This is a doctrine which, in the past, has been exploded pretty thoroughly, and concerning which possibly some of the more progressive element might use Mr. Fry.

* New York City.

Mr. Fry. the term "bunk." If one is dealing with a given subject and that subject has many heads, the correlated heads, as far as possible, should be brought together for better or for worse. It was in support of this principle that there was established recently a United States Department of Labor, because it seemed to be necessary that there should be a Cabinet officer to deal with those subjects which exclusively concern labor and its correlated interests. It is now proposed to extend this principle in establishing a Federal Department of Public Works.

The speaker's opinions are based on service for 34 years under the Navy, the Treasury, and the Departments of Commerce and Labor, and he believes it is beyond dispute that almost every department of the Government has brought together bureaus that bear very little relation to each other. There seems to be no reason why these conditions should exist, or why, for instance, each of these different departments should maintain its own little navy, or its own corps of engineers. Take the matter of surveys. There are no less than three surveys dealing separately with the navigable waters of the United States: the Corps of Engineers of the Army makes lake surveys and some river surveys; the Hydrographic Corps of the Navy makes some coast line and river surveys; and the Coast and Geodetic Survey makes some others. It is the speaker's opinion that no preacher, however distinguished, bearing aloft the standard that "whatever is, is right," can justify any such system as that just described.

Again, there is a little navy in what is now called the Coast Guard; there is another little navy run by the Coast and Geodetic Survey, and still another run by the Department of Commerce, and the speaker would like to ask those apostles of ancient doctrine whether or not they consider such a system desirable.

He knows nothing of this particular bill and, therefore, he is not speaking directly to that bill. He is discussing only a general principle, and that general principle appears to be, as follows: Methods which have been found good for ordinary working affairs, which have proved successful in competition between individuals and between corporations, can be proved successful in conducting departments and bureaus of the Government.

There is no harm in studying these questions, and, as the result of such study, bringing together in one Government department or service those things which should be co-ordinated, and, having brought them together, give them a system of control that would be better for them and for the nation.

Mr. Black. Roger D. Black,* M. Am. Soc. C. E.—In presenting the following remarks, the speaker is conscious of a feeling of temerity based on his lack of complete information regarding the proposition before

* New York City.

the Society, and, in particular, as to the reasons which have led the Society to give such serious consideration to the formation of an entirely new department of the Government to take over important work which has been and is being carried on successfully by existing departments. It may be that the points which he has in mind have been given very thorough and adequate consideration, in which case he realizes that his remarks must be superfluous. However, the tenor of the remarks made by Capt. Fry suggests that amplification of certain phases of the subject may not be out of place. Mr. Black.

In particular, the proposed transfer of the work of river and harbor improvement, and the enforcement of laws for the protection of navigation, from the responsible charge of the Corps of Engineers of the Army to that of the new Department of Public Works is a subject in which the speaker has been for a long time and is now intensely interested and on which he should be fairly well posted.

Before touching on this phase of the subject, however, the speaker desires to interpolate certain suggestions brought to mind by the remarks of Capt. Fry.

The problem in hand is essentially one of organization. It is proposed to combine in a single department a number of existing surveys, the reclamation service, all building construction conducted by the Federal Government, and all works for the improvement of navigation, on the ground that all these things involve engineering and, therefore, can be better administered under a single control. The question arises whether this is not a case of carrying centralization too far. Centralization in organization seems to have proved conclusively desirable when it results in improved definition of responsibility, useful interchangeability of personnel, and ability to procure materials in larger quantities under standard design and with greater flexibility in establishing priorities as to sources of production and for distribution. Whenever a clear gain is not demonstrable on one or more of these points, it becomes over-centralization and tends to defeat precision, economy, and celerity.

By placing a group of highly diversified works under the charge of a single individual, little or nothing is gained in the way of definition of responsibility unless that individual is an expert, competent to direct each line of work so grouped, and the number of questions coming to him for decision is not greater than he has time to handle personally. Otherwise, he must delegate authority commensurate with the responsibility which he is not in a position to discharge in person, and is likely to become an automaton or else a frequent source of useless delay and unwise decision. In any case, the resulting organization is likely to be extremely complicated and cumbersome. On the face of it, it seems doubtful whether the design and construction of buildings, reclamation works, river and harbor engineering, and

Mr. Black. topographical, geological, and hydrographic surveys are sufficiently similar to profit by direction by a single individual, when conducted on so large a scale as in the case of the Federal Government.

Regarding interchangeability of personnel, it is true that a large number of the individuals who do the brain work in these several departments call themselves engineers. In the matter of education, the average engineer spends two years at college studying pure and applied mathematics and the fundamental laws of mechanics. After that, he begins to specialize, going into mechanical engineering, civil engineering, architecture, or what not. Until he reaches the grade of general executive management, he continues to draw apart in training and ability from engineers in other lines than his own. In other words, the personnel which will make up the several branches of the new proposed department cannot be interchangeable and, at the same time, experts in their several lines.

Regarding surveys, as pointed out by Capt. Fry, it is true that the work of the Navy Hydrographic Survey, the Coast and Geodetic Survey, and the United States Lake Survey has in general the same object and is of a similar nature requiring the same type of training. In the matter of distribution of hydrographic charts, it would appear that something material would be gained by having a single agency for their sale. However, as will be pointed out later, there seem to be other and potent reasons for keeping the Lake Survey separate from the Coast and Geodetic Survey, though the speaker is not competent to judge of the need for maintaining the Navy Hydrographic Office as part of the Navy Department. Each of these surveys is large enough to require an organization of sufficient size to gain a high degree of economy in procuring and training personnel in administration, and in the procurement of its supplies. Duplication of work is now avoided through practical arrangements, and, in each case, the survey seems to be under the department having the greatest use for its products and best able to profit by the training which its individual members receive.

It would seem to be perfectly possible to retain the advantages now gained by the present distribution of creative work and, at the same time, have a single agency for the sale of hydrographic charts. As these charts are used almost entirely by mariners, the Department of Commerce would seem to be a proper distributing agency.

Similar reasons exist for the retention of the Geological Survey as a single entity, but a greater reason exists in that its products are intended for an entirely different class of individuals who deal more directly with, and can be reached more readily through, the Department of the Interior than through any other department. A practical working arrangement exists between the Engineer Department of the

Army and the Geological Survey, whereby the work of the latter is made available to the former without unnecessary duplication. Mr. Black.

Generally speaking, the purpose for which the various maps are made and the by-products obtainable in their making should be considered very carefully before the decision is reached to combine the several surveys simply because their work is similar.

The question of combining the Lake and Coast Surveys deserves special consideration. It is apparent that hydrographic surveying is inseparable from river and harbor improvement. In spite of the existence of the Coast and Geodetic Survey, the Engineer Department finds it necessary to carry on hydrographic work in the various waterways being improved. There is little duplication of work, however, because most of these hydrographic maps are of a type which need not be made and are not in suitable form for use as guides for mariners, and whenever they contain data useful to mariners, such data are promptly turned over to the Geodetic Survey which incorporates them in its charts. On the other hand, there are long stretches of coast line and many harbors not under improvement, all of which must be charted for navigation. To have to carry on hydrographic surveys solely for navigation purposes in such harbors would be practically an unrelated burden to the agency charged with river and harbor improvement. Therefore, the present distribution of map-making along the coast seems in many ways to be logical, economical, and profitable.

On the Great Lakes and inland rivers, the situation is different. All the waterways connecting the Great Lakes are under continuous improvement, and practically all the navigable harbors on the Great Lakes are likewise under improvement. Should the Engineer Department make only such surveys as it has to in connection with these improvements, there would be very little left for an independent hydrographic survey, the purpose of which was entirely assistance to mariners. In other words, so much of the work must be done by the Engineer Department for its own purposes, that it seems to be most logical and economical for it to do what is left, and make this work available to mariners in the form of charts. Therefore, to combine the Lake Survey with any other survey would seem only to introduce additional overhead and, possibly, duplication of effort.

Regarding the procurement of supplies for engineering purposes, the three services most concerned would be those having to do with building construction, reclamation, and river and harbor work. All three use plant, and all use a certain quantity of building material. However, the total quantity used is insignificant compared with that used in the general building trades of the country, by municipalities, by private corporations, and by the railroads. It has never seemed to be practicable or desirable to create a single general purchasing agency

Mr. Black.

for all these activities, as the questions of procurement and distribution are altogether too complex.

A close study of the experience of the Army in the war will indicate that where there is a shortage, either in production or in transportation, a centralized control of procurement and distribution is necessary, in order to fix priorities as to sources and the use of facilities; but where it goes beyond this, it is neither economical nor efficient, and operates to retard construction, to hamper individual initiative, and to introduce a tremendous overhead. It is suggested that some agency for the fixing of priorities in both production and transportation might well be retained within the Government, but it should be limited to commodities in which the several Government departments find themselves in active competition. In practice, in peace time, it is believed that these would be very few.

What has been said is suggestive only, and of secondary importance to the speaker's chief theme, which is National military preparedness. It would appear that the country has recently had a sufficient demonstration of the importance of preparedness for National defense. Will it not be extremely difficult for historians 30 or 40 years hence to explain why the United States of America did not stop the great war at least two years before the armistice? As has been stated, it is because we were not in it. The difficulty, however, will be to explain why we were not in it, and the answer will be that we were not prepared, psychically or physically. And, again, why were we not prepared? The question is, can we afford now to be unprepared again or to overlook any practical and reasonable element of preparedness?

The speaker has served in the Corps of Engineers of the Army and on the General Staff. It is believed that there is a not inconsiderable opinion in the General Staff to the effect that the river and harbor work is detrimental to the interests of the Army, that the Corps of Engineers should be relieved from this work and devote its entire time to "soldiering". It is thought that this opinion is most unfortunate, and must be regarded as a measure of incompetency in the General Staff.

It is believed that the war lasted long enough to teach both the General Staff, and the line of the Army in general, the importance of engineering in war, but that it did not last long enough to teach them the real significance and nature of training in engineering. One must regard with serious concern the fact that officers of the General Staff can or do believe that a competent military engineer can be created through the theoretical study of engineering and the process of so-called "engineer drills", or through any other process than the actual handling of important engineering work, with full responsibility for its successful prosecution.

Mr. Black.

It may be advanced that the engineer talent in our next great war will be brought into the Army directly from civil life, as so much of it was for this war, but it is believed that this talent cannot be used effectively unless there are engineers in the Regular Army who are not only trained engineers, but also trained soldiers. The engineering work of the Army, like the work of its artillery, or its infantry, or any other branch of the service, is directed by the commanders concerned, who are usually trained as line officers. Under the present form of organization, detailed plans are prepared for these commanders by their General Staffs. These men will probably be the best tacticians, but it is absolutely essential, if they are to base their plans on engineering possibilities, that, as advisers to the General Staff, there are trained and experienced engineers who can speak the General Staff language, and, as trained and experienced soldiers, have its confidence. It is a fact that, in the fall of 1917 and in the spring of 1918, there was no dearth of trained engineers from civilian life in the army both in France and in the United States; yet until these officers had learned the language of the Army and its organization so well that they had gained the confidence of the General Staff and Commanding Officers in general, they were tremendously handicapped in getting results, and could not be given responsibility and authority commensurate with their ability and potential usefulness as engineers.

It is submitted that the success of the engineer service of the Army in France was made possible by the existence of the officers of the regular engineers who knew and understood the language and the point of view of both the civil engineers who actually did the work without prior military training, and of the General Staff officers and commanders who made the plans which required it. It is also submitted that the officers of the regular engineers would have been unable to do their part in this most excellent team work had it not been for their training in the river and harbor work.

It has been suggested, both in and out of the Army, that the work of building construction, such as used to be done by the Constructing Quartermaster's Corps, and was done, during the war, in this country by the Construction Division, would be an adequate training for the army engineer. It is granted that this is better than pure "soldiering", but it cannot be compared with the river and harbor work, and should not be treated as a substitute for it.

In building construction, one is working against static forces with an artificial and controllable time element. In war, one is working against an active enemy whose plans and potentialities cannot be accurately estimated. It is submitted that engineering work against the active, uncertain, dynamic forces of Nature, as these forces must be combated in the work of river and harbor improvement, is the best sub-

Mr. Black.

stitute that has yet been devised for a human enemy, in training for engineering in war, or even in training for fighting. Rather than take away the river and harbor work from the Corps of Engineers of the Army, it would seem desirable that every officer of infantry, cavalry, and artillery, who is to be a commander of troops, as a part of his training, should be employed at least two years on construction work, and, if possible, on construction work in which the active dynamic forces of Nature must be combated.

It has been suggested that, under the proposed Department of Public Works, officers of the Corps of Engineers be detailed for training purposes. It is believed that this plan is not practicable as a means for securing the desired result. The plan has been tried over and over again of having young officers detailed as observers, or even in minor positions of authority, on river and harbor work, as part of their training in engineering, but it is believed that their real training has never come until they are placed in a position of real responsibility and commensurate authority in which they themselves, without guidance, are called on to make quick decisions on important matters and with complete responsibility for results and for directing the personnel on the work.

Under the plan proposed, these engineer officers could not be detailed permanently to the Department of Public Works and, at the same time, learn the other side of their training as soldiers. It is not conceivable that when detailed for instruction they would find positions of great responsibility, as these would have to be reserved for the permanent personnel of the new Department. When the Chief of Engineers himself is responsible for the work, he has no alternative than to put his officers in responsible positions, and thereby give them the training that is desired. The cost of their mistakes is a recognized legitimate charge against military preparedness, and an investment, which it is believed the war has proven most profitable to the country.

To sum up, it is thought that a strong case may be drawn to show that should the work of river and harbor improvement be taken away from the Corps of Engineers of the Army, a very important element of military preparedness will have been given up deliberately. Does this Society wish to be on record as being in any way responsible for an unnecessary reduction in the military preparedness of our country?

Mr. Flinn.

Alfred D. Flinn,* M. Am. Soc. C. E.—Improvement in the efficiency of government is a necessity of these times, which many realize. Engineers, especially, have perceived the inefficiency of the present method of dealing with public works. National public works particularly require more intelligent management as a whole, and,

* New York City.

Mr. Flinn.

although certain works have been well done in detail, many engineers, and some other citizens who have given the subject thought for years, are convinced that a National Department of Public Works, if properly organized, will secure a large measure of improvement. The ideal cannot be attained by one leap; one step must be taken at a time. With these considerations in mind, the Jones-Reavis Bill was drafted (H. R. 6649-S. 2232). To many engineers and other men having knowledge of works of an architectural or engineering character, the advantages of the proposed step appear to be obvious. Herein lies a danger, in that this group, being satisfied in their own minds, will not comprehend the need for informing and convincing the many others who do not know, or who, knowing, do not accept.

Engineering Council was organized to perform certain duties for the engineers of the United States. In casting about for one of the most important pieces of work which it could undertake, one which would be, not for the selfish advancement of engineers, but for the good of the Nation, it concluded that no more important project could be attempted than the promotion of a National Department of Public Works; therefore, it called a conference in April, 1919, in Chicago, Ill. Because the financial resources of Engineering Council were limited, and because more persons were interested in a National Department of Public Works than the engineers represented directly in Engineering Council, the representatives present from eighty-five organizations decided to form "The Engineers', Architects' and Constructors' Conference." Engineering Council has not ceased its activity since the creation of the new special organization; it is continuing its support of the endeavor in various ways. The work is well launched and is progressing encouragingly; but it must be followed up. Senators and Representatives all over the United States must be informed by "the people at home" of the advantages to be gained by the passage of the Jones-Reavis Bill and of the desire of their constituents for such a measure.

A civilized nation cannot exist without public works, and the United States has invested many billions of dollars in Federal public works which include, in part, buildings of many kinds, harbors, lighthouses, canals, river improvements, dams, irrigation systems, drainage works, power plants, parks, roads, and means for making surveys, maps, and scientific investigations. The growth of the country and the progress of civilization constantly make more and larger public works necessary. What are some reasons for a National Department of Public Works, as proposed?

Public works require technically trained men for construction, operation, and up-keep. The United States should have the best men; they are more likely to be attracted to one well-organized department than to scattered bureaus.

Mr. Flinn. In the United States, public works have been assigned unsystematically, until to-day they are in charge of twenty-six bureaus in five Cabinet departments*. Overlapping and rivalry result inevitably. Some items are slighted; others are beneficiaries of "pork barrels". Such lack of system causes waste in equipment, material, and labor, as well as in supervision and accounting. Many of these faults could be corrected by assembling public works in one department. Other departments would then be freer to do the work especially assigned to them.

Many millions of dollars annually can be saved, and much better results can be obtained by one suitably organized department.

Such assembling of public works would lead to clearer responsibility and greater efficiency.

A National Department of Public Works would simplify the National budget; indeed, it is a necessary pre-requisite to a successful budget system.

A National Department of Public Works would be a strong feature of industrial and military preparedness.

A National Department of Public Works would quickly supplement and sustain the Military and Naval establishments in the event of war.

A National Department of Public Works could aid the several States in connection with their public works.

These reasons are not new, and others can be given. The enactment of the bill now before Congress will not achieve immediately an organization as good as could be devised; its passage, however, will be a long step in the right direction, and further steps can be taken more easily.

Engineers alone cannot put the project through. Business men, farmers, and mechanics should be convinced of its merits. The establishment of a National Department of Public Works would make for the general welfare, and, therefore, the endeavor to create it should have general support.

Mr. Dunham. H. F. Dunham,† M. Am. Soc. C. E.—It is of interest to consider the extent of the public work which Mr. Fuller has outlined and note where the Government function is to begin and end. Nothing in Mr. Fuller's brief or discussion precludes Government control of public works throughout the country. A department could be created and made as exclusive in its field of operation as the Post Office Department is now. References in his discussion to needed work throughout the country appear to favor this plan. Each State, however, has its Board of Public Works, also, its Board of Health, and River and

*Bulletin No. 17, October 3d, 1919, of Engineers', Architects' and Constructors' Conference on National Public Works.

† New York City.

Harbor Commissions. Are these to be superseded? Are they to be supervised by a Washington department? Mr. Dunham.

There is an advantage in having the source of information and the source from which funds are supplied close to the place where the object is to be accomplished—where the work is to be done; and immediate or near-by supervision and direction are even more helpful.

If the county in Florida now boasting a $50 000 post-office, where there should be a $3 000 one, had been obliged to pay for its post-office, or if the State of Florida had been the agent to design and pay for it, there would be no such structure in that location. It is distance from those who control, and a feeling that other people, not his constituents, will have to pay, that leads the politician into such extravagances.

A few years ago, the Governor of North Carolina was congratulated on the fact that two school houses per day had been built during a year of his administration. That Governor would have been quite disconcerted if he had found a $20 000 school building in a place requiring one that cost $3 000.

A tendency to have more public work under the direction of the State and less under the control of politicians at Washington can be defended. The Post-Office Department uses State-made highways for the conveyance of its mails. Let it rent State-made buildings for the distribution of letters. There would then be greater economy, more than one style of post-office architecture, and fewer scandals. The Geodetic network, properly covers many States, but some of those States join in the topographical surveys. More attention should be given by the Government to a State like California, with its millions of acres of National land, than to Connecticut without one acre. From one viewpoint, the Government at Washington should greatly increase its public works activities; from another, those activities should be gradually decreased by the transfer to State authority of many functions. Definite information as to the intent and the general effect of the changes recommended should be required in reaching a conclusion.

MEMOIRS OF DECEASED MEMBERS

NOTE.—Memoirs will be reproduced in the volumes of *Transactions*. Any information which will amplify the records as here printed, or correct any errors, should be forwarded to the Secretary prior to the final publication.

CHARLES TITUS CHURCH, M. Am. Soc. C. E.*

DIED AUGUST 25TH, 1919.

Charles Titus Church, the son of the Rev. Samuel Clemon Church, D. D., and grandson of Capt. Samuel Church, the pioneer founder for whom Churchville was named, was born at Churchville, N. Y., on October 6th, 1834. His mother, Mary Hall (Bangs) Church, was also of early New England ancestry—a great-great-great-great granddaughter of Edward Bangs the Pilgrim who came from England in the *Anne* in 1623. She came from Massachusetts to make her home in Western New York in 1822.

While Dr. Samuel C. Church was pastor of the Methodist Episcopal Church, in Medina, N. Y., his son, Charles, received his academic education at the Medina Academy. He then entered Union College, from which he was graduated, with the class of 1856, with the title of Graduate in Civil Engineering and the degree of Bachelor of Arts.

In March, 1857, Mr. Church went to Iowa and served as Rodman on the preliminary surveys for a railroad from Dubuque to Anamosa. In June, he became interested in the proposed improvements for using the water power on the Illinois side of Rock Island, but after he had designed the masonry dams, etc., the plans for this enterprise were abandoned.

In 1859, Mr. Church became a teacher in charge of a graded school at Port Byron, Ill., and, from 1861 to August, 1862, he was Superintendent of the public schools of Rock Island, Ill. From August, 1862, to July, 1864, he was engaged "in land operations" with an office at Moline, Ill.

In July, 1864, he went to Colorado in the employ of a gold mining corporation, and made topographic surveys of the mountain passes at the head-waters of the Arkansas, South Platte, and Blue Rivers and reaching over the Great Divide to the Pacific Slope. A portion of this survey was afterward used by the Pacific Railway's explorers. Mr. Church then returned to Illinois where he remained during October and November, going East in December to New York City to

* Memoir prepared by the Secretary from information on file at the Headquarters of the Society.

complete the maps of the survey, which were turned over to the Copalinshe Mining Company.

In July, 1866, he was employed as Mining Superintendent by the Champion Silver Mining Company and, in its interests, went, *via* the Isthmus of Panama, to San Francisco, Cal., and thence to Silver Peak, Nev. He made a thorough examination and a report of the Company's property at Silver Peak, but the owners decided to defer mining operations, and Mr. Church returned to New York City.

From 1867 to 1869, he served as Agent for the American Tunnel Machine Company, directing the operation of the draftsmen and model maker. In the meantime, in November, 1868, he returned to railroad work, as Transitman on a preliminary survey for the Lake Shore Railroad from Middletown to Willimantic, Conn.

In March, 1869, he was appointed as Transitman on preliminary surveys for the New York, Ontario, and Western Railroad in Delaware and Sullivan Counties, New York State. In September of that year, he was made Assistant Engineer on Construction of the same road, which position he held for three years until the track was laid and the work completed.

In 1873, Mr. Church was engaged with the Central Railway Construction Company, of New York City, as Draftsman and Office Engineer, and from January, 1874, to May, 1875, he served as Clerk in the "eastbound" office of the Erie Railroad Company at Long Dock, Jersey City, N. J.

In May, 1875, he was appointed Assistant Engineer on the Lake Ontario Shore Railroad, in charge of construction through Oswego, N. Y. This work consisted of carrying a railroad bridge across the Oswego River and out to the new harbor.

In 1876 and 1877, Mr. Church was engaged in farming in Michigan and teaching school in Monroe County, New York State. In November, 1877, however, he went to Boston, Mass., as Office Engineer, Draftsman, etc., for Col. T. H. Dupuy, Consulting Engineer for the Boston, Hoosac Tunnel, and Western Railroad Company, which position he retained until 1880.

From August, 1880, to the fall of 1881, he was engaged on the location and construction of the Saratoga Lake Railway as Assistant Engineer and Acting Chief Engineer, respectively, and, from that time, until October, 1882, he served as Chief Engineer of the Boston Hoosac Tunnel Railroad.

From 1882 to 1886, Mr. Church was employed as Chief Engineer on the surveys, betterments, etc., for the Lebanon Springs Railroad, leaving this position to engage on location surveys for the Housatonic

and Northern Railroad from the State Line, on the Boston and Albany Railroad, to Bennington and North Bennington, Vt.

In 1887, he served as Chief Engineer on the location and construction of a railroad from Derby to Botsford, Conn., in the interest of the Housatonic Railroad Company, and, in 1888 and 1889, he was engaged in the private practice of engineering, with an office at Saratoga Springs, N. Y.

From March to July, 1890, Mr. Church was employed as Assistant Engineer by the Lehigh Valley Railway Company on construction covering the crossings of the Genesee River and Oatka Creek, and from October, 1890, to October, 1892, he served as Civil Engineer for the Retsof Mining Company on mine surveys, mapping, and railroad construction connecting the mine with the Delaware, Lackawanna, and Western Railroad, as well as with several other railroads near Caledonia, N. Y.

From October, 1892, to July, 1895, Mr. Church was employed as General Freight and Passenger Agent of the Genesee and Wyoming Valley Railroad Company, and from that time until 1899, he was engaged in private practice, surveying, mapping lands, etc.

In the meantime, his family had become residents of Geneva, N. Y., and, in 1899, Mr. Church became identified with the municipal government of that city, serving for two years as City Engineer and afterward as City Engineer and Superintendent of Public Works until 1912, when he resigned and retired from active work. He continued his residence in Geneva where he died on August 25th, 1919. He is survived by a nephew and several nieces.

Mr. Church was married, in New York City, on August 26th, 1873, to Miss Frances Ann Van Zandt, daughter of Beekman and Frances Susanna (Van Buren) Van Zandt. Mrs. Church died on October 14th, 1910.

Mr. Church was thorough and accurate in all his work and undertakings, as thorough in his reading as in other things, a reader of many books, papers, and magazines, and interested in events of the day to the very last. Hospitable, gallant, suave—something of the type of the "old-school gentleman"—with an excellent memory, keen wit, and remarkably lucid expression of his thoughts or opinions, Mr. Church was a delightfully entertaining host; but he did not care to visit his club or other places where men usually gather; he liked the quiet of his home. He was a member of the University Club, the Elks, and the Masons, but never held office in any of them. He was a Vestryman of Trinity Protestant Episcopal Church, in Geneva, N. Y., from 1894 to 1917, and for some years served as Clerk of the Vestry.

Mr. Church was elected a Member of the American Society of Civil Engineers on May 1st, 1889.

JOHN VOSE HAZEN, M. Am. Soc. C. E.*

DIED OCTOBER 2D, 1919.

John Vose Hazen was born at Royalston, Mass., on November 22d, 1850. Later, the family resided in Atkinson, N. H., and he was prepared for college at Atkinson Academy. He was graduated from the Chandler Scientific Department (as it was then known), in 1875 with the degree of B. S., and from the Thayer School of Civil Engineering in 1876, with the C. E. degree. The College gave him the A. M. degree in 1908.

From September to December, 1876, Mr. Hazen was employed as Rodman on the Manchester and Keene Railroad, and then served as Principal of the High School at Hancock, N. H., until April, 1877. From April to July, 1877, he was Draftsman for the Boston Bridge Works, and from August, 1877, to July, 1878, Principal of Atkinson Academy. From September, 1878, he served for two years as Tutor in Mathematics and Surveying in the Chandler Scientific School, and then as Professor of Civil Engineering and Mechanics until 1894. From that time until 1911, he was Woodman Professor of Civil Engineering and Graphics in the Scientific Department of Dartmouth College, as re-organized, and also Professor of Civil Engineering in the Thayer School of Civil Engineering.

In the summer season of 1881, Professor Hazen was engaged for three months on a survey of the Connecticut River, at Sumner's Falls, Plainfield, N. H., for a proposed dam. In the summer of 1891, he acted as Chief of Party on the survey of the preliminary line and location of the Hoosac Tunnel and Wilmington (Vt.) Railroad. In the summer of 1900, he was engaged as Chief of Party, for three months, conducting a survey for a proposed electric railroad from Ely Station, Vt., to the Copperfield Mines, in the interest of the late George Westinghouse, M. Am. Soc. C. E., who then owned the copper mines.

From 1900 to 1910, Professor Hazen served as Chairman of the Board of Commissioners of the Village Precinct of Hanover, N. H. He devoted himself diligently to the duties of this office which afforded little emolument and small thanks. He designed and supervised the construction of sewers and drains, and gave much attention to the construction of better roads, building short stretches of good macadam roadway and improving those parts most liable to deterioration. In 1909-10, he was engaged as Expert in the design and layout for an extensive coal-tar-concrete street pavement, in Lebanon, N. H. In 1910, he served his town as Expert in the grading of, and also super-

* Memoir prepared by Robert Fletcher, M. Am. Soc. C. E.

vised the construction of that part of, the New Hampshire State Highway, "West Side Trunk Line", within the town limits. Professor Hazen was always particularly interested in road construction, and labored to secure the passage, by the New Hampshire Legislature, of a general law to establish a State Highway Department which would control road construction throughout the State, thus giving a more efficient and economical administration. The advent of the automobile hastened the result which he so much desired. During the last twenty years, he did considerable expert surveying in Court cases. Being rather modest and undemonstrative in manner, many did not appreciate his ability; but those who consulted him on professional questions found him well-informed, well acquainted with sources of information, and ready to apply his knowledge to the case at hand.

In 1889, Professor Hazen attended the joint conventions of the American Societies of Civil and Mechanical Engineers, the Institution of Civil Engineers, and the French Society of Engineers, in London and Paris. He afterward traveled for a few weeks in Switzerland and England.

As a teacher, Professor Hazen was painstaking and faithful, and had the high respect and regard of his students. He was more particularly interested in descriptive geometry, railroad surveying, highway construction, and foundations. At a time when the means of pictorial presentation of his subjects were not as available as at present, he prepared many large-scale drawings and diagrams to elucidate his lectures and classroom demonstrations. During many years, he directed the preliminary course in Surveying given to Juniors in College. At the same time, he had charge of the Railroad Surveying and instruction in Railroad Construction given to the first-year class in the Thayer School of Civil Engineering. If all the lines which he projected had been built, Hanover would be a great "railroad center". Among the young men of his classes, Professor Hazen's "stride" was proverbial. In the routine fieldwork few could get over more ground than he, so rapidly, and with, apparently, so little effort. The railroad surveys occupied entire days, the parties taking along their lunches, and it was a rare man who, at the end of the day, would show so little evidence of fatigue as Professor Hazen. There were few, if any, instructors or professors who conducted more classwork than he. There were times when he spent from 28 to 30 hours per week in the classroom, including some two-hour exercises and work with students of the Thayer School. Sometimes, with very large classes, he had to get along without as much help from assistants as he would have wished. However, he seldom grumbled, although he was overburdened, but often said that, at the worst, professors and most of the instructors in college have an easy life, free from much of the anxiety and hard

toil which is the lot of the average man. Always ready for duty, he cheerfully accepted the tasks which came to him, and accomplished what some would have regarded as much more than his share.

Professor Hazen died at his home in Hanover, on October 2d, 1919, after suffering from a disability which had gradually increased from early in the summer. He was so well known to successive classes of students through more than 40 years that his passing beyond must awaken the deep sympathy of many who will share in the grief of his family and immediate colleagues.

Professor Hazen was married to Miss Harriet A. Hurlbut, of Hanover, N. H., and his family of two sons and two daughters exemplified the best ideals of home life and neighborly relations. They have, in the recollections of his accomplished lifework, an abiding and precious heritage. He was a member and a regular attendant of the Congregational Church. He had been a member of the School Board for eighteen years, and Treasurer of the Dartmouth Religious Society for many years. Professor Hazen set an example of unflagging devotion to duty and readiness to discharge every responsibility as a citizen, exemplifying the familiar maxim of Smeaton: "The abilities of the individual are a debt due to the common stock of public well being". He had many friends and no enemies, and has left a memory to be cherished by his family and his neighbors.

Professor Hazen was elected an Associate of the American Society of Civil Engineers on June 5th, 1889, and a Member on May 2d, 1911.

JOHN GIBSON HENDRIE, M. Am. Soc. C. E.*

DIED JUNE 18TH, 1919.

John Gibson Hendrie, the son of Daniel and Jessie Gibson Hendrie, was born on December 17th, 1881, at Philadelphia, Pa.

He received his early education in Philadelphia, attending the Central High School from 1897 to 1901. He entered the University of Pennsylvania in 1902, where he took a four-year course in Civil Engineering, which he completed in June, 1906.

Mr. Hendrie gained his early experience as a Civil Engineer, with the Trussed Concrete Steel Company, the Pennsylvania Railroad Company, Franklin and Clarke, and McCormick and Company, respectively. For the last-mentioned firm, he acted as Resident Engineer in charge of the engineering work on the construction of the Mulberry Street Bridge at Harrisburg, Pa.

* Memoir prepared by George A. Huggins, Esq., Philadelphia, Pa.

He served as Engineer for Weeks and Sanville until 1911, when he went with the Barber Asphalt Paving Company, and was located at Maurer, N. J., in charge of construction work until 1913. Mr. Hendrie was then sent to Brighton, Trinidad, as Engineer in charge of the Asphalt Works at that place. He returned to Maurer in 1916, and remained there until he resigned to enter the Engineers Corps of the Army.

He was commissioned a Captain in the Reserve Corps on August 15th, 1917, and served with that rank from September, 1917, until July 30th, 1918, when he was commissioned a Major.

Maj. Hendrie served in France until he was detached and ordered back to the United States to assist in the training and development of a new battalion of Engineers. He resigned from the service in December, 1918, and went to Fort Worth, Tex., as Engineer with the Pierce Oil Corporation, where he remained until his death on June 18th, 1919.

Of Scotch descent, Maj. Hendrie inherited the best Scottish traits and characteristics. He was very active in football, rowing, and other undergraduate activities during his High School and College courses. He was a member of the Phi Delta Theta Fraternity and was elected Cane Man of his class in college.

He was married on April 26th, 1913, to Maria Elizabeth Roessler, of Perth Amboy, N. J., who, with three children—Donald, Elizabeth Roessler, and John Gibson—survives him.

Maj. Hendrie was elected a Junior of the American Society of Civil Engineers on September 5th, 1911, an Associate Member on April 2d, 1913, and a Member on May 12th, 1919.

GEORGE STEVENS LEAVENWORTH, M. Am. Soc. C. E.*

DIED AUGUST 8TH, 1919.

George Stevens Leavenworth was born on August 17th, 1858, at Charlotte, Vt. He was graduated from the University of Vermont in 1885, with the degree of Civil Engineer.

After serving a short time with the United States Coast and Geodetic Survey, and with the City Engineer of Burlington, Vt., Mr. Leavenworth, in March, 1886, took up location and construction work on the Burlington and Missouri Railroad, the Marietta and North Georgia Railway, the Knoxville Southern Railway, and the Missouri, Kansas, and Eastern Railway.

In April, 1896, he went into street railway and hydro-electric development work, on which he was employed, chiefly in Massachusetts and New York State, until about 1901, when he returned to steam

* Memoir prepared by W. H. Mansfield, M. Am. Soc. C. E.

railroad construction on the Manitoulin and North Shore Railway, the Algoma Central Railway, and the extension of the Little Kanawha Railroad.

In 1903, Mr. Leavenworth resumed street and interurban railway work as Chief Engineer of the Powers and Mansfield Company, of Troy, N. Y., in which work he continued until about 1912, when he engaged in railroad and mining engineering in the South. In this connection, he was employed with the Carolina and Yadkin River Railroad and the Tennessee Copper Company, continuing in that work until his death which occurred at his home in Ducktown, Tenn., on August 8th, 1919. He is survived by his wife, who was Miss Sarah H. Smith, of Charlotte, Vt.

Mr. Leavenworth was quiet and unassuming in manner and had a lively sense of humor. He had a keen analytical mind, and his aptitude for railroad location was very great. His integrity was never question, and his honesty of purpose impressed all who had dealings with him. He represented fully the highest type of engineer, and all who knew him have suffered a loss by his death.

Mr. Leavenworth was elected an Associate Member of the American Society of Civil Engineers on June 3d, 1903, and a Member on February 5th, 1907.

BRUCE RITCHIE HONEYMAN, Assoc. M. Am. Soc. C. E.*

DIED OCTOBER 5TH, 1918.

Bruce Ritchie Honeyman was born at Portland, Ore., on December 30th, 1885, of Scotch parents. He received his early schooling at the Portland Academy, from which he went to the Massachusetts Institute of Technology and was graduated from there in 1906.

On his return to Portland, Mr. Honeyman was employed as Structural Engineer with Morris H. Whitehouse, Architect, and remained with the firm for some years. He then went with the Hurley-Mason Company as Structural Engineer, designing and superintending the construction of several buildings. He left this Company to go to work in Vancouver, B. C., Canada, for the Norton-Griffiths Company. After the completion of his work there, Mr. Honeyman went to St. Paul, Minn., and, for eleven years, was employed as Engineer by the F. J. Romer Construction Company. At the time of his entry into the military service, he held the position of Manager of General Contracting and Construction for the Company.

On May 11th, 1917, Mr. Honeyman entered the military training camp, at Fort Snelling, Minn., as a civilian candidate for a commis-

* Memoir prepared by George C. Mason, M. Am. Soc. C. E.

sion in the Engineers. He was transferred later to the Central Training Camp for Engineers, at Fort Leavenworth, Kansas, where he was assigned for instruction to the 13th Provisional Training Regiment. He served with this regiment as a candidate until August 14th, 1917, when he was graduated. On August 15th, 1917, he was commissioned as Captain of Engineers, United States Army, and assigned to duty at Camp Dodge, Iowa, with the 313th Engineers, in command of Company A.

Capt. Honeyman proceeded overseas with his regiment during the early part of September, 1918, and served with it until September 28th, 1918, at which time he was confined to quarters on account of sickness which later developed into pneumonia, resulting in his death on October 5th, 1918. Maj.-Gen. W. M. Black, M. Am. Soc. C. E., Chief of Engineers, states concerning Capt. Honeyman's service with the United States Army: "His services were satisfactory in every respect," and it would seem to those who knew him that these words express the opinion of his work throughout his entire career.

In June, 1909, he was married to Marion Blakely, of Tacoma, Wash. He is survived by a daughter, Elinor, and a son, Blakely.

Capt. Honeyman was elected an Associate Member of the American Society of Civil Engineers on September 5th, 1911.

WILLIAM MENKE, Assoc. M. Am. Soc. C. E.*

DIED NOVEMBER 1ST, 1918.

William Menke, the son of John and Louise Sommers Menke, was born at New York City, on December 2d, 1885. His early education was received in the public schools of New York, and, in 1904, he entered Columbia University, from which he was graduated with the degree of Civil Engineer in 1908.

Immediately after his graduation, Mr. Menke was employed as Draftsman and Transitman, on the construction of a 2 000-h. p., hydroelectric plant at Walden, N. Y.

In February, 1909, he entered the employ of the New York Board of Water Supply as Engineering Inspector in the Reservoir Department, in connection with the construction of the Catskill Aqueduct. After about one year as Inspector, at Brown's Station, Mr. Menke was appointed an Assistant Engineer with the Water Board, and transferred to the Southern Aqueduct Department near White Plains, N. Y. While in this Department he was in charge of the field work on the construction of the concrete cut-and-cover aqueduct, steel pipe siphon,

* Memoir prepared by Ralph E. Drake, Assoc. M. Am. Soc. C. E.

and gate-chambers, at Scarsdale, N. Y. He was engaged for about two years in this work. He was then transferred to the City Aqueduct Department, in the Manhattan Division, and was employed on the construction of a 48-in., cast-iron main and, subsequently, on two shafts and the tunnel from 23d Street to 42d Street, New York City.

In August, 1914, Mr. Menke left the Water Board and received an appointment as Engineer with the New York Public Service Commission, First District, on subway construction in New York City. He was in the Commission's employ for two years as Assistant to the Section Engineer, having had charge of the field parties and office work on the construction of the Lexington Avenue line between 43d and 53d Streets. The work on this section, valued at more than $2 000 000, consisted of a four-track, steel and reinforced concrete structure, which was built partly in open cut and partly in tunnel. To the regret of his associates, he resigned in August, 1916, to accept a position as Draftsman and Designer with the Bethlehem Steel and Bridge Company, at its plant in Steelton, Pa.

Mr. Menke's next move carried him back to New York City, where, in June, 1917, he entered the employ of the J. G. White Engineering Corporation. For the first few months, he was engaged as Designer and Draftsman in the New York office, and was then sent to Kingston, N. Y., where he was Assistant to the Resident Engineer and, later, Resident Engineer, on a 50-mile, 60 000-volt, transmission line.

In June, 1918, Mr. Menke accepted a position as Field Engineer with the Construction Department of The Babcock and Wilcox Company, at its plant in Barberton, Ohio. Activities here consisted of alterations and improvements to existing buildings, the erection of a new machine shop, the installation of electric cranes and other machinery, and improvements and reconstruction work on plant railroad lines, craneways, etc. Mr. Menke's duties were arduous, but he always performed them with a willing and cheerful spirit. This, his last, position as Engineer on industrial plant construction, was one for which he felt he was particularly fitted and in which he was best satisfied to work.

Mr. Menke's work was always well and carefully done, and he was held in high esteem by his numerous associates, both for his valuable, painstaking, faithful services and his pleasing personality. His quiet, unassuming nature and his consideration for others endeared him to all with whom he came in contact.

He died on November 1st, 1918, at the Citizens' Hospital, Barberton, Ohio, a victim of influenza followed by pneumonia, his death having occurred after an illness of one week. He was unmarried.

Mr. Menke was elected a Junior of the American Society of Civil Engineers on December 6th, 1910, and an Associate Member on April 16th, 1918.

ALEXANDER CHARLES SCHILLING, Assoc. M. Am. Soc. C. E.*

DIED FEBRUARY 4TH, 1919.

Alexander Charles Schilling was born at New York City, on October 20th, 1886. He acquired his early education in, and was graduated from, the public schools of that city. Later, he received private instruction, and also studied at the Morris High School and the College of the City of New York.

From October, 1904, to July, 1917, with the exception of a short period (October, 1905, to February, 1906), when he was engaged as Transitman with the Rapid Transit Railroad Commission of New York City, Mr. Schilling was employed in the office of the President of the Borough of the Bronx, New York City. In this position, he was engaged chiefly in the construction of sewers and roads.

In July, 1917, he was appointed Assistant Engineer, and, later, Chief of Sewers, United States War Department, and, in this capacity, he designed and constructed sewage works, including septic tanks and disposal plants, located and constructed buildings, theatre, barracks, etc., and supervised the construction of concrete roads, water supply, etc., at Camp Meade, Md.

Of Mr. Schilling's work at Camp Meade, Leo Hudson, Assoc. M. Am. Soc. C. E., who was associated with him there, writes:

"Mr. Schilling came to Camp Meade, Md., from New York City, and proved to be a tireless worker and a man of great worth. He was ambitious and strove continually to improve his own condition and the conditions of those with whom he was associated. His coming to Camp Meade was a personal and professional sacrifice, brought about through a high sense of patriotic duty to help his country in its time of need. He did important work while at Camp Meade, and was there practically from the beginning to the ending of the work. He left behind a good record and a spirit of good fellowship. He left Camp Meade to undertake other work for the Government, which work paid salaries less than those he could have secured from his former employers. He was a splendid young man, and his death is a loss to both the country and the Profession."

On December 19th, 1917, Mr. Schilling was appointed Field Assistant with the U. S. Geological Survey, and had charge of a party controlling areas for topographic mapping. Later, he was detailed in connection with military mapping and served in this capacity until he left the service, on January 15th, 1919.

Mr. Schilling was taken ill while on his way to Mobile, Ala., where he had accepted a position in the U. S. District Engineer's Office. He

* Memoir prepared by the Secretary from information on file at the Headquarters of the Society.

died in Mobile, on February 4th, 1919, from influenza, followed by broncho-pneumonia. His death came as a great shock to his family and to all his associates.

He was married on September 24th, 1910, to Miss Grace Mattock Willey, of New York City, who, with two children, Alexander Ralph and Grace Marjorie, survives him.

Mr. Schilling had a keen appreciation of Nature, and was a lover of outdoor life. His boyhood days were spent largely in the woods, and he was greatly interested in ornithology, having had, at one time, a large collection of live birds. He was a vigorous young man, and no amount of work phased him. All his leisure time, and most of his working hours, were spent in the open. Several years ago, he was the possessor of an auxiliary sloop yacht, and his knowledge of the channels, together with his excellent eyesight, made him a capable captain. He had explored the country by motorcycle and automobile, and was extremely fond of travel, quoting many, many times:

> "To him who in the love of Nature holds
> Communion with her visible forms, she speaks
> A various language;"

Mr. Schilling was elected an Associate Member of the American Society of Civil Engineers on June 18th, 1918.

ROBERT EARLE SHIPLEY, Assoc. M. Am. Soc. C. E.*

DIED OCTOBER 11TH, 1918.

Robert Earle Shipley, the son of Dr. John L. and Mary E. Shipley, was born on December 30th, 1887, at Cullychoha, Indian Territory. His parents died when he was a small boy, and he made his home with his aunt, Mrs. Sarah McConnell. After finishing the public schools, he entered the High School in his home town, and, later, the University of Arkansas, from which he was graduated with the degree of B. C. E., in June, 1911. He was a member of the Phi Kappa Alpha Fraternity.

Mr. Shipley's professional career was as follows: March to August, 1909, Field Draftsman, with the Arkansas Co-operative Constructing Company, Bentonville, Ark., on preliminary and location surveys; July to December, 1911, Inspector of levees and dredge ditches, St. Francis Drainage District; December, 1911, to April, 1912, Draftsman on drainage surveys; April, 1912, to June, 1913, Engineer and Assistant

* Memoir prepared by J. H. Brillhart, M. Am. Soc. C. E.

Superintendent for A. B. Wills and Sons, Drainage Contractors, on the inspection of drainage districts, making estimates, designing dredge boats, etc.; June to November, 1913, Field Engineer for James R. Rhyne, Assoc. M. Am. Soc. C. E., in charge of the preliminary survey for a 30 000-acre drainage district; November, 1913, to September, 1914, Resident Engineer for the Marion County Drainage District, supervising the construction of levees, open and title ditches, as well as the erection of a pumping station and the installation of two 30 000 gal. per min., electrically-driven centrifugal pumps; February to September, 1914, also Chief of a field party on a levee and ditch location survey for the South Quinch Drainage District; October, 1914, office work with the Morgan Engineering Company; November, 1914, to November, 1915, made a drainage survey and reported on 300-acre farm and drainage and irrigation investigations in the Southwest; from November, 1915, to the summer of 1918, when he entered the military training camp, Mr. Shipley was employed as Drainage Engineer, for the Texarkana Pipe Works, making drainage surveys, designs, estimates, and reports, closing contracts and superintending all the drainage construction work for the Company.

He entered the First Engineer Officers' Training School, at Camp A. A. Humphreys, Va., in June, 1918, where he died of influenza on October 11th, 1918.

He was married to Miss Helen Cook, of Texarkana, Ark., on June 27th, 1918, and is survived by his wife, and two brothers, Lieut. John I. Shipley, M. D., U. S. N., and Elvin M. Shipley, now stationed at Great Lakes, Ill., in the Aviation Service of the United States Navy.

Of Mr. Shipley, L. L. Hidinger, M. Am. Soc. C. E., Vice-President of the Morgan Engineering Company, says, "He was connected with our firm only a short time, but we were impressed with his stability of character, steadiness, and reliability." Mr. G. R. Layne, of the Texarkana Pipe Works, writes of him as follows: "My acquaintance with Mr. Shipley dates from the time he entered my employ about four years ago. He was with us three years as Drainage Engineer, principally on agricultural work, and I esteemed him very highly, not only for the value of his services, but as a thorough gentleman."

Mr. Shipley was a man of high moral character, modest and unassuming. Owing to the fact that his father died when he was still young, he was thrown on his own resources, and the record that he made in his short life, shows that he was efficient and thorough, and that the Profession lost a valuable man by his death.

Mr. Shipley was elected an Associate Member of the American Society of Civil Engineers on October 9th, 1917.

HUGO S. SPEIDEL, Jun. Am. Soc. C. E.*

DIED JUNE 17TH, 1919.

Hugo S. Speidel was born at Rock Island, Ill., on September 3d, 1866. He obtained his early education in the public schools of that city, and, in 1888, received the degree of Civil Engineer from the University of Illinois.

Mr. Speidel began his engineering career, in July, 1885, as Chainman and Rodman on the construction of the St. Joseph and Iowa Railroad (Rock Island Lines), near St. Joseph, Mo. In June, 1886, he was transferred to Kansas, and was employed on the construction of the Chicago, Kansas, and Nebraska Railroad (also Rock Island Lines), serving first as Draftsman in the general office and, later, as Assistant in charge of a 10-mile division at Sabetha, Kans. After the completion of this division in January, 1887, Mr. Speidel was appointed Transitman on the location of the line through Kiowa County, Kansas, and when the location work was finished, he was given charge of the construction, first of a 10-mile division, and, later, of a 20-mile division, of the line. About July, 1887, he was placed in charge of the construction of all bridges in Kiowa County.

After the completion of this work in September, 1887, Mr. Speidel left the railroad service to enter the University of Illinois, in order to complete the senior year of his college course and obtain his degree.

Immediately after his graduation, he moved to Paterson, N. J., and in July, 1888, entered the employ of the Passaic Bridge Company as Civil Engineer.

In 1898, Mr. Speidel purchased an interest from Mr. David Henry, of Paterson, N. J., in a general building business, and in June, 1900, the David Henry Building Company was incorporated with Mr. Speidel as President, which position he held at the time of his death on June 17th, 1919.

About 1904, Mr. Speidel removed from Paterson and established his residence in Saddle River Township, Bergen County, N. J., and, in 1916, when the Borough of East Paterson was incorporated, he was appointed its first Mayor, which office he held until his death.

He was married on December 20th, 1893, to Adaline S. Speidel, of Urbana, Ill., and is survived by a daughter, Marion W. Speidel.

Mr. Speidel was elected a Junior of the American Society of Civil Engineers, on February 5th, 1890.

* Memoir prepared by the Secretary from information on file at the Headquarters of the Society.

PAPERS IN THIS NUMBER

"EXPERIMENTS ON THE FLOW OF WATER THROUGH CONTRACTIONS IN AN OPEN CHANNEL." E. W. LANE.

"THE PRODUCTION OF TOLUOL FROM GAS PLANTS." MYRON S. FALK.

PAPERS AND DISCUSSIONS CURRENT IN PROCEEDINGS

"Cement Joints for Cast-Iron Water Mains." CLARK H. SHAW.....Mar., 1917
Discussion.....May, Aug., "

Final Report of the Special Committee on Steel Columns and Struts.....Dec., "
Discussion.....Feb., Mar., Apr., Aug., Oct., 1918

"Verification of the Bazin Weir Formula by Hydro-Chemical Gaugings."
FLOYD A. NAGLER.....Jan., "
Discussion. (Author's closure.).....
Mar., May, Aug., Nov., 1918, Oct.-Nov.-Dec., 1919

"Construction Methods Used in Building the Lower Reservoir Dam of the Balmorhea Project." VERNON L. SULLIVAN. (Author's closure.).....
Apr., 1918, Oct.-Nov.-Dec., "

"Emergency Construction Work Due to War Conditions, With Especial Reference to the Construction Division of the Army." GEORGE W. FULLER.....May, 1918

"The National Railroad Question of To-Day." FRANCIS LEE STUART.....Feb., 1919
Discussion.....Mar., Apr., May, "

"On a New Principle in the Theory of Structures." GEORGE F. SWAIN.....Mar., "
Discussion.....May, Aug. Sept., Oct.-Nov.-Dec., "

"The East Canyon Creek Dam." A. F. PARKER.....Mar., "
Discussion.....May, Aug. Sept., "

"Pressures in Penstocks Caused by the Gradual Closing of Turbine Gates."
NORMAN R. GIBSON.....Apr., "
Discussion.....May, Aug., "

"Sewage and Wastes Disposal for the United States Army." LEONARD S. DOTEN.....May, "
Discussion.....Aug., Sept., Oct.-Nov.-Dec., "

The Proposed New York and New Jersey Vehicular Tunnel: An Informal Discussion.....May, Aug., "

American Highways: An Informal Discussion.....May, Aug., Oct.-Nov.-Dec., "

"Water Supply for the Camps, Cantonments and Other Projects Built by the Construction Division of the United States Army." DABNEY H. MAURY.....Aug., "
Discussion.....Sept., Oct.-Nov.-Dec., "

"Contracts—A Comparison of 'Cost Plus' with Other Forms." ERNEST WILDER CLARKE.....Aug., "
Discussion.....Oct.-Nov.-Dec., "

"Physiography of Water-Sheds and Channels, and Analysis of Stream Action of Southern California Rivers, with Reference to the Problems of Flood Control." A. L. SONDEREGGER.....Aug., "
Discussion.....Oct.-Nov.-Dec., "

"Comprehensive Plotting of Water Turbine Characteristics." KARL R. KENNISON.....Aug., "

"The Silt Problem of the Zuni Reservoir." H. F. ROBINSON.....Aug., "
Discussion.....Oct.-Nov.-Dec., "

"The Accuracy of Water Level Recorders and Indicators of the Float Type."
J. C. STEVENS.....Aug., "

Is It Advisable to Establish a National Department of Public Works?: An Informal Discussion.....Oct.-Nov.-Dec., "

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